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OCTOBER 1956

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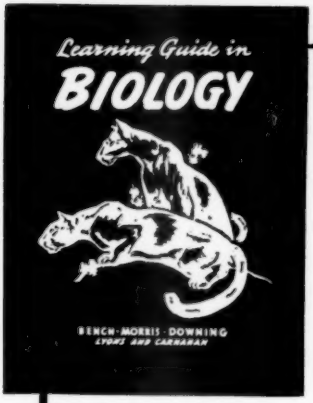

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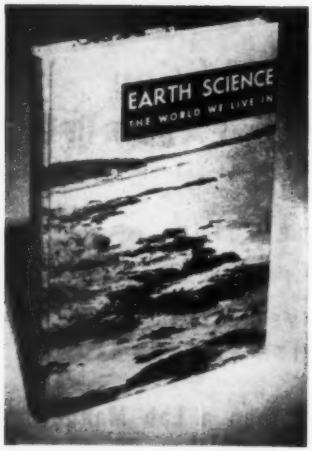

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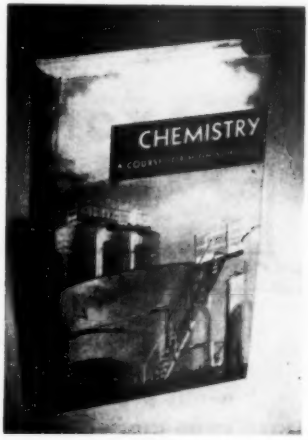

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And quietly brooding,
It hatches all sorts of horrible things.—BROOKS.

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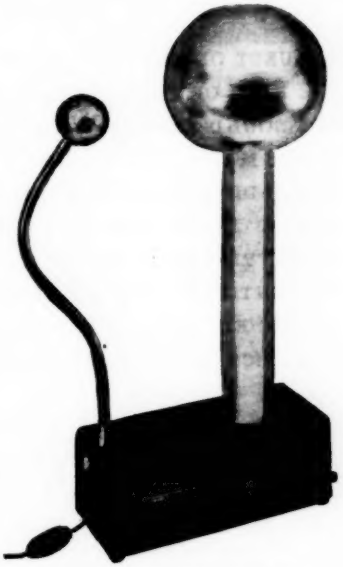

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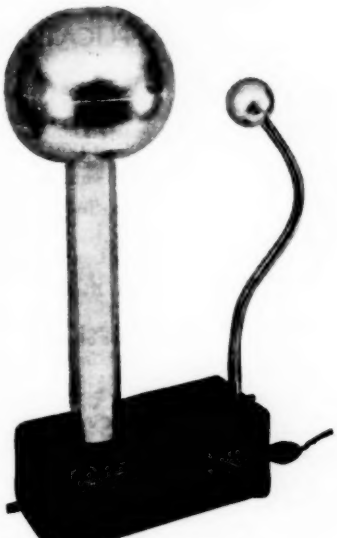

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FLUORINE—THE MOST ACTIVE NON-METAL

LAWRENCE G. KNOWLTON
Western Michigan College, Kalamazoo, Mich.

Moissan, who is well known for his method of making synthetic diamonds, discovered fluorine in 1886. Due to its great chemical activity other scientists including the great electro-chemist, M. Faraday, failed in their attempts to discover it.

PREPARATION OF FLUORINE

Moissan produced fluorine by an electrolytic method that is very similar to that employed today for its commercial preparation. Since fluorine reacts violently with water it is necessary to keep the starting materials, hydrogen fluoride and potassium hydrogen fluoride, free from moisture. The potassium hydrogen fluoride must be added to the hydrogen fluoride since the latter does not conduct electricity. The matter of a material for use in construction of the fluorine cell becomes a problem because of the activity of the fluorine. However dry fluorine is less corrosive than might be expected. At ordinary temperatures steel, copper, aluminum and glass are not attacked under the conditions just named.

The modern cells, made of carbon steel, use a molten electrolyte of approximate composition $KF \cdot 2HF$ and operate at temperatures of 95°–115°C. Anodes are carbon with steel being used for cathodes. Current efficiency of 95% has been attained.

CHEMICAL BEHAVIOR OF FLUORINE

Being in the upper right hand corner of the periodic table fluorine is the most active of the non-metals. As evidence of this such non-flammable materials as asbestos, brick, and water will ignite and

burn in a stream of fluorine. Steel, at dull red heat, catches fire in fluorine. Hydrogen burning in fluorine can produce a temperature of 3750°C. For comparison the temperature of the oxyhydrogen flame is 2800°C. and that of the oxyacetylene flame is 3500°C. Fluorine unites directly with all elements except chlorine, nitrogen, oxygen, and the members of the rare gas family.

Because of its great activity fluorine exists in nature chemically combined and as a consequence its compounds are very stable which, as we shall see later, has considerable practical significance.

Use of Fluorine for Separation of U^{235}

During the recent world war fluorine chemistry received a considerable impetus with the discovery that gaseous uranium hexafluoride, UF_6, could be used in an effective method for separating the isotope of uranium, U^{235}, from the more abundant isotope U^{238}. The U^{235} was used in the first atomic bombs. It is difficult to find a compound of an element with a high atomic weight, such as uranium, which volatilizes readily. Thus the fact that uranium hexafluoride has a vapor pressure of one atmosphere at 56°C. makes it possible to use it in the diffusion method of separation.

The diffusion method is based on the fact that light gases diffuse through barriers more rapidly than heavy gases. The relative rate of diffusion of two gases is based on Graham's Law which is represented by the following formula:

$$\frac{S_1}{S_2} = \sqrt{\frac{M_2}{M_1}}$$

S_1 and S_2 represent the speed of diffusion of the two gases. M_1 and M_2 represent their molecular weights. When the molecular weights of the hexafluorides of the two isotopes of uranium are substituted in the equation, we get:

$$\frac{S_1}{S_2} = \sqrt{\frac{352}{349}}$$

Solving this we find that $U^{235}F_6$ will diffuse 1.004 times as fast as $U^{238}F_6$. Thus each time the mixture passes through a membrane or barrier the $U^{235}F_6$ concentrates to the extent of .4%. Therefore to obtain adequate separation many thousands of separations or stages are necessary. Although this process seemed impractical it proved to be the most satisfactory of the various methods tried. Seventy huge buildings occupying 6000 acres, each large enough to house several football fields, and costing over $500,000,000 were erected by the

government at Oak Ridge where the U^{235} is separated in a most efficient manner.

Fluoridation of Water

One of the most interesting of the practical applications of fluorine compounds is the use of fluorides, such as calcium fluoride, in drinking water to prevent tooth decay or caries. There is evidence that the effect of fluorides in reducing tooth decay was known as early as 1901. In this country the pioneer work was carried out by McKay and Black who showed that there is a relation between caries and the fluoride content of the drinking water. However, if the fluoride content of the water exceeds 2 parts per million a mottled or stained condition of the teeth results.

In 1944 under the auspices of the National Institutes of Health a ten year study was instituted at Grand Rapids to determine the effect of fluorides on the prevalence of caries. The fluoride content of the water was maintained at 1 part per million. Muskegon was chosen as a control city. After five years the following results were found in the reduction of carries.

Age Group	*Per Cent Reduction in Caries*
5	72.7
6	51.3
9	36.4
13	16.7
16	12.7

It can be seen that fluorides are less effective in reducing tooth decay among older children. Adults are not benefited by them. Topical application of 2% sodium fluoride solution to children's teeth is beneficial in situations in which they do not receive fluoride otherwise.

It is unfortunate that apprehension over the use of fluorides has led to opposition to its use in many communites. No good evidence has been presented to prove that fluorides in the concentrations used are harmful. The small amount required to combat tooth decay could not have any ill effects. Studies of people in communites where the fluoride content of the water is as high as 8 parts per million have revealed no ill effects. The use of fluorides has been endorsed by the American Medical Association. As of November 1955, 1,066 communities with a total population of 20,450,000 fluoridate their drinking water.

The Freons and Their Uses

Many organic, fluorine containing compounds are known. Perhaps

the most familiar of these are the Freons. The Freons can be considered as being hydrocarbons with most or all of their hydrogen replaced by chlorine and fluorine. The following table lists several of them.

TABLE I

Freon Number	Formula	Boiling Point Centigrade
11	CCl_3F	24°
12	CCl_2F_2	−29.8°
13	$CClF_3$	−81.4°
14	CF_4	−127°
22	$CHClF_2$	−41°
113	$CCl_2F–CClF_2$	48°

The Freons became well known as the result of a search by Midgely and Henne for an ideal refrigerant which would be: nonexplosive, nontoxic, nonflammable, non-corrosive, non-irritating, odorless, and non-injurious to foods, flowers, etc. It also should have a suitable boiling point and be practical from a mechanical standpoint.

The search was initiated in 1920 and in 1930 the Freons, possessing the properties indicated above, began to be used. They have proved so satisfactory that other refrigerants, previously used, have been largely replaced. With the growing use of mechanical refrigeration and air conditioning Freons will be used in ever increasing amounts.

Freons are also used, almost exclusively, as a propellant in aerosol producing devices. An aerosol can be defined as a suspension of fine liquid or solid particles in a gas. These particles can be as small as 1/5000 inch in diameter and due to their minute size can float in the air for as long as two hours. Aerosol bombs were first used extensively in World War II as insect repellants. They were responsible for cutting down the prevalence of malaria among our armed forces.

Following the war the development of light weight metal containers instead of the heavier type stimulated the use of aerosols. In 1954, 200 million units were sold.

A mixture of Freon 11 and 12 is most generally used in the bomb. As can be seen in Table I their boiling points are low enough to create a vapor pressure which forces the contents out of the bomb.

FLUOROPLASTICS

Tetrafluoroethylene, C_2F_4, and trifluorochlorethylene, C_2ClF_3, in their polymerized solid form have proved to be extremely useful. The former goes under the trade name of Teflon, the latter Kel-F. Perhaps their most outstanding characteristic is their great stability. Only

molten alkalies and fluorine attack Teflon. Kel-F is attacked by these and also halogenated organic compounds. They are useful over a temperature range of $-100°$ to 350°F. Some of the applications for which they have been found useful because of their stability are: gasket material, valve packing and tank linings. Its non-adhesive properties make it useful for rolls for dough in bakeries and for stop cocks for chemical glassware. Both fluoroplastics have high electrical resistance and other properties that make them extremely valuable in the electrical industry for uses such as insulation of coaxial cable, coatings for magnet wire, and supports for radar antennas.

Miscellaneous Fluorine Compounds

Well known, useful, compounds of fluorine which deserve mention are: calcium fluoride, sodium aluminum fluoride, and hydrogen fluoride. Calcium fluoride occurs naturally as fluorspar. It is the source of hydrogen fluoride as well as other fluorine containing compounds and is used as a fluxing agent in metallurgy and in glass manufacture. Sodium aluminum fluoride, Na_3AlF_6, occurs as a mineral known as cryolite. It also can be used in glass production but its main use is to lower the melting point of the electrolytic bath from which aluminum is produced. Aluminum oxide, the other constituent of the bath, has a very high melting point. One pound of cryolite is required for every ten pounds of aluminum produced. The supply of natural cryolite is limited making necessary the use of a synthetic variety made from aluminum oxide which occurs as bauxite. More synthetic cryolite is made in the United States than is imported.

Hydrogen fluoride is well known as an etching agent for glass but has numerous other important uses such as: fluorine production, as a source of fluorine for other compounds, cleaning ceramic products, and as a catalyst for synthesis in the petroleum industry.

The consumption of fluorine and fluorine containing compounds is increasing rapidly. A great deal of work is being done in the field of organic fluorine containing compounds which will undoubtedly lead to other useful ones being discovered to join the Freons and fluoroplastics. Fluorine chemistry and fluorine chemicals deserve their share of attention along with that of their fellow halogens.

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JULIUS SUMNER MILLER
El Camino College, El Camino College, California

There is general agreement among us, I believe, that physics students are not too excited about laboratory sessions. I am sure too, that we (the teachers) are often not too satisfied with the laboratory business. There has been much said and much written about it in recent years. A complaint which generally prevails is that the laboratory period reduces to a cookbook affair—read this, do it—read that, do it! The *overall* scheme of things, the Gestalt, so to speak, is obscured by the details on the printed page, and the student loses sight of the larger principles. In recent years I have attempted a departure which I wish here to report.

I use no laboratory manual; I have no instruction sheets. The equipment is available to the student on the sideboard. I give 20 minutes to a half hour to a discussion of the physics which is to occupy us for the next two hours or more. This is equivalent, I suppose, to the theory which appears on the printed pages of laboratory manuals. I sketch the set-up and call attention to observations to be made. I *may* give *formal* instruction in two or three abbreviated lines on the blackboard. From here on the student *experiments*. The write-up is brief. I realize the shortcomings which can be pointed up, but I fear there are no Utopian schemes. One large aspect, and an important one in my own thinking, is that some *spirit of exploration* and some *feeling for investigation* prevail. It has been very heartening to me to discover that the student's spirit in this kind of a laboratory session is sensibly higher.

MATHEMATICS PRIZE COMPETITION AT LOS ANGELES CITY COLLEGE

The Mathematics Department of Los Angeles City College is pleased to announce the results of the 6th annual William B. Orange Mathematics Prize Competition for students in Los Angeles High Schools. The two hour written examination was held May 18, 1956 with 167 students from 35 local high schools participating.

Team winner for the second consecutive year was Van Nuys High School, placing 5 students in the top eight. Runnerup was Hamilton High School.

Individual winner was Mike Raugh of Van Nuys High School, followed by Howard Weisberg and Harold Stark of Hamilton High School. Louis Jaeckel of Van Nuys was fourth and Floris Yung Tsang of Los Angeles High School fifth.

The team prize is the William B. Orange perpetuating Prize Trophy. Individual prizes consist of cash, slide rules, mathematics books, and subscriptions to mathematics magazines.

THE CIRCUMCIRCLE, THE INCIRCLE, THE NINE-POINTS CIRCLE AND THE CIRCLE THROUGH THE FEET OF THE BISECTORS OF THE ANGLES OF THE TRIANGLE

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University of Toronto, Toronto, Canada

1. *The Circumcircle, Incircle and Nine-points Circle*

It is well known that the circles relating to a triangle have many interesting properties and students in pure mathematics do well to become familiar with them. I describe here a few properties which I have culled from books and journals, hoping to induce some of my readers to follow in my steps.

Denote the circumcenter, incenter, nine-points circle center, orthocenter and centroid by O, I, N, H and G respectively, and the radii of the circumcircle, incircle and nine-points circle by R, r and n respectively.

The relationships between R, r, the sides a, b, c, the angles A, B, C of a triangle ABC, the perimeter $2s$ and the area S of the triangle are given in many textbooks. The expressions $r=S/s$ and $R=(abc)/(4s)$ are useful for quick calculations.

It is known to many students that $HNGO$ lie on a straight line (the Euler line), that $HN=NO$ and $HG=2GO$, also because the circumcircle passes through the vertices of the triangle ABC and the nine-points circle passes through the middle points of the sides BC, CA, AB that $n=R/2$.

To these facts may be added the following expressions proved in the Trigonometries

$$OH^2=R^2(1-8\cos A\cos B\cos C) \tag{1}$$

$$OI^2=R^2\left(1-8\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}\right)=R^2-2Rr \tag{2}$$

$$IH^2=2r^2-4R^2\cos A\cos B\cos C. \tag{3}$$

IN is a median of the triangle OIH and therefore by the well known relation for the median

$$IN^2=\frac{OI^2}{2}+\frac{IH^2}{2}-\frac{OH^2}{4}$$

we find

$$IN^2=\left(\frac{R}{2}-r\right)^2 \tag{4}$$

$$\therefore IN = \frac{R}{2} - r = n - r \tag{5}$$

This last statement tells us that the incircle and the nine-points circle must touch each other at a point in NI produced. This point is called the Feuerbach point. It is designated by U in the diagrams that follow. Naturally the two circles have a common tangent at U.

Other interesting and useful expressions are

$$IA \cdot IB \cdot IC = 4Rr^2 = abcS/s^2 \tag{6}$$

$$NA^2 + NB^2 + NC^2 = R^2\left(\frac{11}{4} + 2\cos \quad \cos B \cos C\right) \tag{7}$$

$$NA^2 + NB^2 + NC^2 + NO^2 = 3R^2 \tag{8}$$

$$(R+r)/R = \cos A + \cos B + \cos C \tag{9}$$

Note 1. Approximately O is towards the longest side, H towards the largest angle, I and U towards the angle of intermediate size.

Note 2. If one angle of the triangle is a right angle O is at the middle point of the hypotenuse and H at the right angled corner so that $OH = R$—in agreement with Eq. 1 (See Figs. 3 and 4).

Note 3. If $IO = IH$ one of the angles of the triangle must be 60°. This may be proved theoretically (See Figs. 4 and 7 for examples). If $B = 60°$, the Euler line produced makes an equilateral triangle with AB, BC.

Note 4. If $IO = IH = OH$ then $\cos A + \cos B + \cos C = 3/2$.

Note 5. If one angle is 90° and another 60°, $OH = R$, $OI^2 = R^2 - 2Rr$ and $IH^2 = 2r^2$. On equating OI to IH we find $R = r(1+\sqrt{3})$ (see Fig. 4).

References may be made to the different Geometry and Trigonometry textbooks. I have used the following:

S. L. Loney, *Plane Trigonometry* (Camb. Univ. Press, 1908), Ch. XV.
E. W. Hobson, *Plane Trigonometry* (Camb. Univ. Press, 1917), 3rd ed., Ch. XIII, §158, pp. 198–201.
R. A. Johnson, *Modern Geometry* (Houghton Mifflin Co., N.Y., 1929), Ch. XI, pp. 165, 195, 200.
N. Altshiller-Court, *College Geometry* (Johnson Publishing Co., N.Y., 1925), Ch. II, Part V, §§ 161–165, 422.

Many notes on the Feuerbach point have been written in the Mathematical Journals. Most are difficult to follow and one purpose of this note is to persuade students to make good diagrams for themselves. Select data which will give well proportioned triangles i.e. those in which the principal points H, N, G, O, I are well separated.

Make as large a diagram as you can using a *good* straight edge* and a *good* pair of compasses. You will then have much pleasure in seeing the figure grow under your eyes, and accurate measurements of the important distances should confirm the trigonometrical expressions. Do this frequently.

If you use coordinate geometry and *good* squared paper the coordinates of the important points can be calculated and confirmed. Of course the theoretical work gives results which are true for all triangles. Calculations from one triangle alone affords a confirmation but not really a proof of any theorem. However, once you have made triangles of different shapes and drawn or plotted the circles and located and calculated their important points you will be convinced of the truths embodied in the above statements.

Checks on your drawings:

(1) The position of the Incenter I may be calculated from the following expressions. Let the coordinates of A, B, C be x_1y_1, x_2y_2, x_3y_3 respectively. Then

$$x_I=\frac{ax_1+bx_2+cx_3}{a+b+c},\quad y_I=\frac{ay_1+by_2+cy_3}{a+b+c} \tag{10}$$

This is easily proved from angle-bisector and intercepts relations. Strangely enough it is not often quoted in the textbooks.

(2) The inclination of OI to BC is $\tan^{-1}\left(\dfrac{\cos B+\cos C-1}{\sin B-\sin C}\right)$ (11)

(3) The location of the Feuerbach point may be found from a knowledge of O and I only. From A drop a perpendicular AS on OI produced. The image of S in the line joining the mid-points of the sides CA, AB gives the position of U. Vertices B and C may, similarly be used.

2. *The Circle through the Feet α, β, γ of the Bisectors $A\alpha$, $B\beta$, $C\gamma$ of the Angles A, B, C, of a Triangle.*

Just as I had found by careful drawing that the incircle and nine-points circle had the property summed up by the Feuerbach point and subsequently learnt that this was common knowledge to the mathematicians I had also found in the same way that the $(\alpha\beta\gamma)$ circle passed through the Feuerbach point. Again I learnt that this was already known. As far as my reading goes this theorem was first stated and proved by F. H. V. Gulasekharam in a note to the *Mathematical Gazette* of London, Vol. 25, 1941, p. 55. It has subsequently

* Many rulers become slightly curved with age. To check use the ruler to draw a long (straight) line on paper. Revolve ruler 180° about this line. Draw again the line. See if the two lines coincide.

been discussed by B. E. Lawrence in the same journal, Vol. 29, 1949, p. 18. The proofs are however difficult to follow.

Let T be the center of the $(\alpha\beta\gamma)$ circle and t its radius. I have not found any simple relations existing between the position of T and the value of t and the sides and angles of the main triangle. This is a field for research.

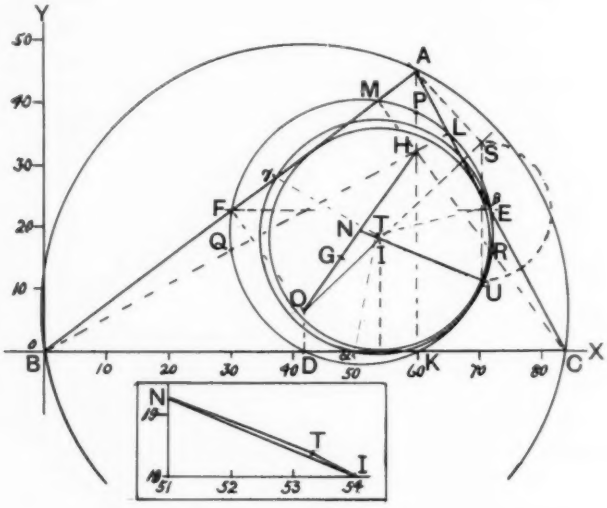

FIG. 1

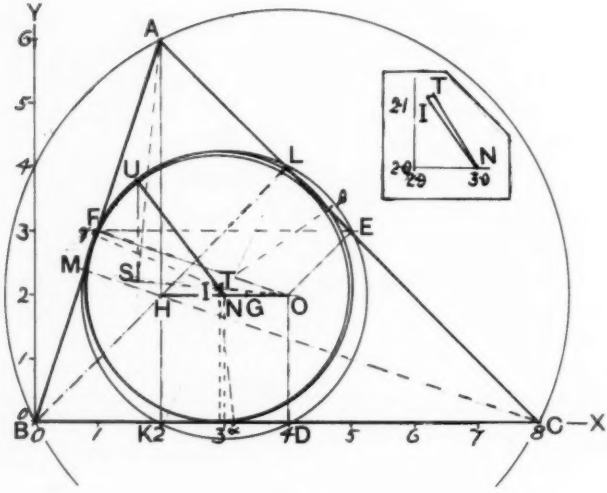

FIG. 2

I give below the details and diagrams of six circles which will convince the draughtsman of the truth of the expressions given above, viz.

(1) the nine-points circle and the inscribed circle touch at the Feuerbach point U;

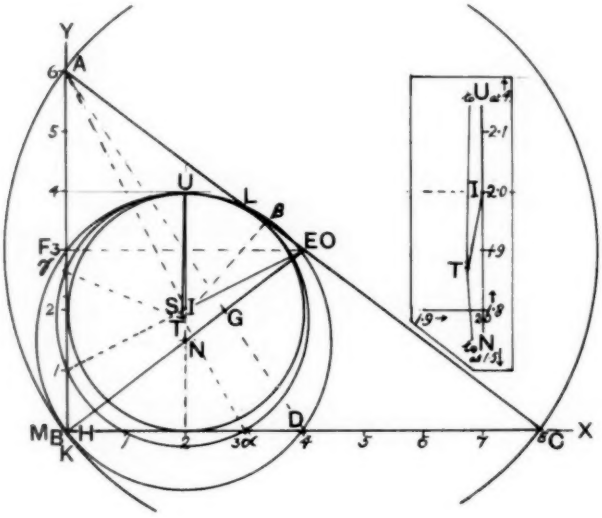

FIG. 3

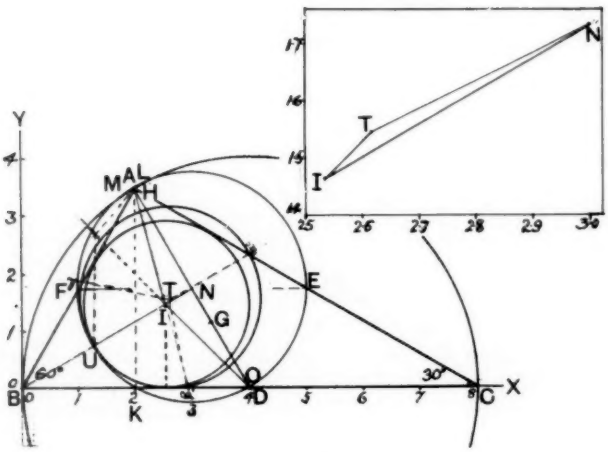

FIG. 4

(2) the $(\alpha\beta\gamma)$ circle also passes through U but is not tangential to the above mentioned two circles, except when the triangle is isosceles.

Figures (1) to (5) which follow show the diagrams for five different but carefully selected triangles. In all cases D, E, F are the midpoints of the sides, K, L, M are the feet of the perpendiculars drawn from the vertices upon the opposite sides. These perpendiculars are often called the altitudes or the orthogonals. The points where the bisectors of the angles meet the opposite sides are designated by α, β and γ. The nine-points circle, the incircle and $(\alpha\beta\gamma)$ circle have their centers at N, I, T and have radii n, r, t respectively. The Feuerbach point is U.

The value of the $\angle NUT$ has been worked out. It is small so that the $(\alpha\beta\gamma)$ circle cuts the other two circles at quite a small angle. The sides of the ΔNIT have been evaluated and it is seen that the $\angle NTI$ is very obtuse.

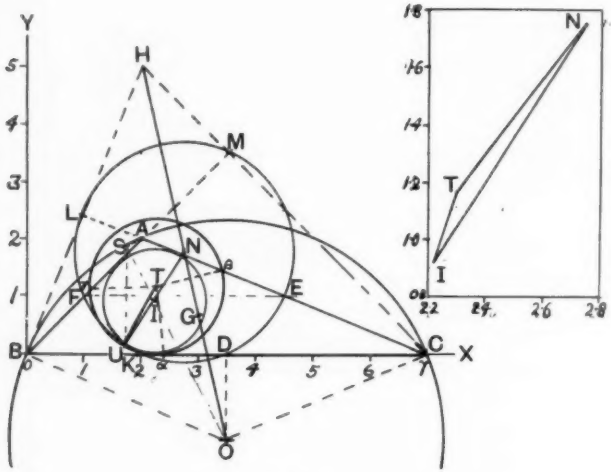

FIG. 5

(1) A conveniently shaped triangle for drawing and calculation was described by W. Hope-Jones in the *Mathematical Gazette* (London), Vol. 24, 1940, p. 54. He recommends the use of inch and tenth-inch squared paper with a tenth-inch as the unit of length. His dimensions of the triangle are $a=84$, $b=51$, $c=75$, whence $s=105$, $S=1890$, $R=42\frac{1}{2}$, $r=18$, $n=21\frac{1}{4}$.

Taking the origin of coordinates at B, axis of x horizontally along BC, axis of y vertically the coordinates of the different chief points are $A(60, 45)$, $B(0, 0)$, $C(84, 0)$. Centroid $G(48, 15)$, Circumcenter

$O(42, 6\frac{1}{2})$, Incenter I (54, 18), Orthocenter H (60, 32), Nine-points circle center $(51, 19\frac{1}{4})$.

The sine, cosine, tangent of the angles and tangent of the half angles are as follows: $A(84/85, 13/85, 84/13, 6/7)$, $B(3/5, 4/5, 3/4, 1/3)$, $C(15/17, 8/17, 15/8, 3/5)$. The reason for giving the tangents of the half-angles is that $a = r(1/\tan B/2 + 1/\tan C/2)$ etc. (Remember $\tan A/2 = (-1 \pm \sqrt{1+\tan^2 A})/\tan A$). This expression affords another method of calculating r. All the numbers given above are exact; the angles A, B, C are approximately $80\frac{1}{2}°$, 37°, 62° respectively.

Fig. 1 shows the triangle and its circles. Note the points of contact. Drawings show, but calculations prove more accurately so I make the calculations also. I keep the exact numbers as integers, with or without the addition of simple fractions, and work out the other data to five or more significant figures.

(2) *Calculation of the position of the Feuerbach point in the triangle of Fig. 1.*

We easily deduce from the known position of O, H, N and I the equations of the line NI and the incircle and nine-points circles. They are

$$x + 2.4y - 97.2 = 0 \tag{12}$$

$$(x-54)^2 + (y-18)^2 = 18^2 \tag{13}$$

$$(x-51)^2 + (y-19\tfrac{1}{4})^2 = 21\tfrac{1}{4}^2 \tag{14}$$

respectively.

To find the coordinates of the Feuerbach point substitute the value of x from Eq (12) in Eq (13). This gives us

$$y_u^2 - 36y_u + 276.0710 = 0$$

whence $y_u = 11.077$, accurate to five figures. Or, if we substitue from Eq 1 in Eq 3 we find

$$y_u^2 - 38\tfrac{1}{2}y_u + 303.7633 = 0$$

whence $y_u = 11.077$ as before. Consequently by substitution of y_u in Eq (12) we get $x_u = 70.615$.

(3) *Calculation of the circle* $(\alpha\beta\gamma)$ *of Fig 1*

To get the coordlnates of α, β, γ use the well known theorem that the bisectors of the angles of a triangle divide the opposite sides into parts whose ratio is that of the adjacent sides about the angle bisected. This yields $\alpha(50.0)$, $\beta(37800/53 = 71.321,\ 1260/53 = 23.773)$, and $\gamma(112/3 = 37.333,\ 28.0)$.

Substitution of these coordinates in the general equation of a circle namely

$$x^2+y^2+2gx+2fy+c=0 \qquad (15)$$

gives, on solution, $g=-53.3962, f=-18.402, c=283.962$. The center T of the $(\alpha\beta\gamma)$ circle is at $(-g, -f)$. The radius $t=(g^2+f^2-c)^{1/2}=18.713$.

MEASURES OF THE TRIANGLES OF FIGURES 2–5

	Fig. 2	Fig. 3	Fig. 4	Fig. 5
A	2, 6	0, 6	2, 3.46410	2, 2
B	0, 0	0, 0	0, 0	0, 0
C	8, 0	8, 0	8, 0	7, 0
a	8	8	8	7
b	$6\sqrt{2}=8.48526$	10	$4\sqrt{3}=6.92820$	$\sqrt{29}=5.38516$
c	$2\sqrt{10}=6.32456$	6	4	$2\sqrt{2}=2.82842$
s	11.40491	12	9.46410	7.60679
S	24	24	13.85640	7
R	$2\sqrt{5}=4.47214$	5	4	3.80787
n	$\sqrt{5}=2.23607$	$2\frac{1}{2}$	2	1.90394
r	2.10436	2	1.46410	0.92023
NI	0.13171	$\frac{1}{2}$	0.53590	0.98371
H	2, 2	0, 0	2, 3.46410	2, 5
O	4, 2	4, 3	4, 0	$3\frac{1}{2}, -1\frac{1}{2}$
N	3, 2	2, $1\frac{1}{2}$	3, 1.73205	$2\frac{1}{4}, 1\frac{3}{4}$
I	2.91964, 2.10436	2, 2	2.53590, 1.46410	2.22162, 0.92023
G	$3\frac{1}{3}$, 2	$2\frac{2}{3}$, 2	$3\frac{1}{3}$, 1.15470	3, $\frac{2}{3}$
U	1.63570, 3.77174	2, 4	1.26795, 0.73205	1.72754, 0.14401
α	3.14601, 0	3, 0	2.92820, 0	2.41051, 0
β	4.64914, 3.35086	$3\frac{3}{4}, 3\frac{3}{4}$	4, 2.30940	3.43889, 1.42444
γ	0.97056, 2.91169	0, $2\frac{1}{2}$	1.07180, 1.85640	1.13038, 1.13038
T	2.9319, 2.1086	1.9762, 1.8691	2.6188, 1.5470	2.2911, 1.1638
t	2.11+	2.1318	1.5781	1.1691
TU	2.10+	2.1312	1.5781	1.1692
$\angle TUI$	20 minutes	38 minutes	66 minutes	193 minutes
ΔNIT				
NI	0.1317	0.5000	0.5359	0.9837
IT	0.0130	0.1331	0.1173	0.2595
TN	0.1282	0.3699	0.4239	0.7396

(3) The distance of T the center of this circle from U, the Feuerbach point is

$$\{(x_T-x_U)^2+(y_T-y_U)^2\}^{1/2}$$
$$=\{(53.396-70.616)^2+(18.402-11.077)^2\}^{1/2}$$
$$=18.712$$

hence the circle $(\alpha\beta\gamma)$ passes through U.

(4) *Difference between the slopes of NIU and TU*

The tangent of the angle NIU makes with BC

$$=(y_N-y_I)/(x_N-x_I)=(19\tfrac{1}{4}-18)/(54-51)=5/12$$
$$=0.4167$$

The tangent of the angle TU makes with BC

$$=(y_T-y_U)/(x_T-x_U)=(18.402-11.077)/(70.615-53.396)$$
$$=7.325/17.219=0.4254.$$

TU is therefore steeper than NU, the angle TUN being only about 23 minutes of arc.

The triangle NIT (see inset in Fig 1) has sides $NI=3.250$, $NT=2.542$, $TI=0.725$. The sum of NT and $TI=3.267$ so that the $\angle NTI$ is very obtuse (it is 166°).

The details of Figs. 2–5 are given in the table opposite.

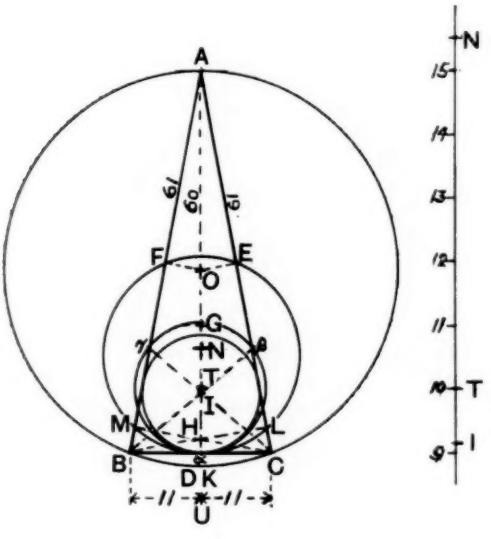

FIG. 6

NOTES ON THE TRIANGLES OF FIGS. 2–5

Fig. 2. The Euler line $HNGO$ is parallel to BC.

Fig. 3. As in all right angled triangles O is at the middle of the hypotenuse and H at the right angle. The circumcircle and the nine-points circle touch each other at the right angle. In the 6-8-10 triangle the line NIU is parallel to the side 6, OI is $\perp AI$, S is at I.

Fig. 4. In the 90°-60°-30° triangle drawn, TI is inclined to the hypotenuse at 45°. Since the angle $B=60°$ (Note 3, p. 2) $IO=IH$. Also $BO=R$ (obviously), $BH=2R\cos B$ (always) $=R$. Hence $BO=BH$.

B is in the straight line with U, I and N and the line $BUIN$ is $\perp$ to and bisects OH.

Fig. 5. In this obtuse angled triangle O and H are outside the triangle and the three circles, i.e. the nine-points circle, the incircle, and the $(\alpha\beta\gamma)$ circle are more separated.

Fig. 6 shows an isosceles triangle of sides $a=22$, $b=c=61$ and altitude $=60$. Calculation shows that $S=660$, $s=72$, $R=31.0083$, $n=15.5042$, $r=9\frac{1}{6}=9.1667$, $t=10.0066$. The important points lie on the medial line through A and their heights above BC are $O=28.9917$, $G=20.0000$, $N=15.5042$, $T=10.0066$, $I=9.1667$, H 2.0167, $U=0.0000$. The nine-points circle, the incircle and $(\alpha\beta\gamma)$ circle touch internally at U. The triangle NIT reduces to a straight line as shown in the inset; $NI=6.3375$, $IT=0.8399$ and $TN=5.4976$.

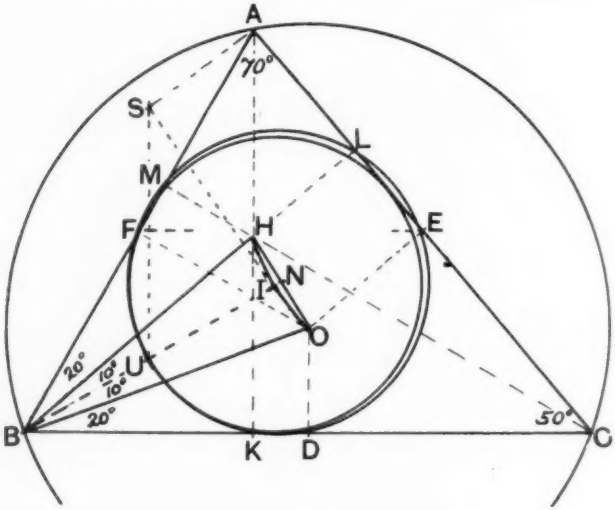

FIG. 7

If the triangle ABC is equilateral all the important points coalesce at the center of the triangle and the nine-points circle, incircle and the $(\alpha\beta\gamma)$ circle are equal in size. We may say that U is distributed around the circumference of this common circle.

Fig. 4 is a right angled triangle with one angle $=60°$. Fig. 7 illustrates a more general case of a triangle with one angle (B) equal to 60°. Note $IO=IH$, $BO=BH$, the line $BUIN$ is $\perp$ to and bisects OH. Also the angle $OBIH=\angle A\sim\angle C$. The $\Delta OBIH$ is centrally situated within the $\angle B$ if ΔABC is acute angled (Fig. 7), fills $\angle B$ if the triangle is right angled (Fig. 4) and is centrally situated about $\angle B$ if the triangle is obtuse angled.

If we keep $\angle B = 60°$ and start with a large angle at A, O is below BC and H beyond A. As we decrease A (and therefore increase C) O and H move towards each other, coincide when $\angle A = \angle C = 60°$ and move apart as A is further decreased and C increased. The ΔOIH becomes an equilateral triangle when $\cos A + \cos B + \cos C = 3/2$. The obvious place for this to happen is when $\angle$'s B and C approach indefinitely near to 60° i.e. ΔABC becomes equilateral, and ΔOIH indefinitely small.

Lawrence has announced another property of the circle through the feet of the angle bisectors. It is illustrated in Fig. 8. Here as before $A\alpha$, $B\beta$, $C\gamma$ are the angle bisectors and the circle through α, β, γ, cuts the sides again in α', β', γ'. The new property is that the larger chord of the three chords $\alpha\alpha'$, $\beta\beta'$, $\gamma\gamma'$ is equal to the sum of

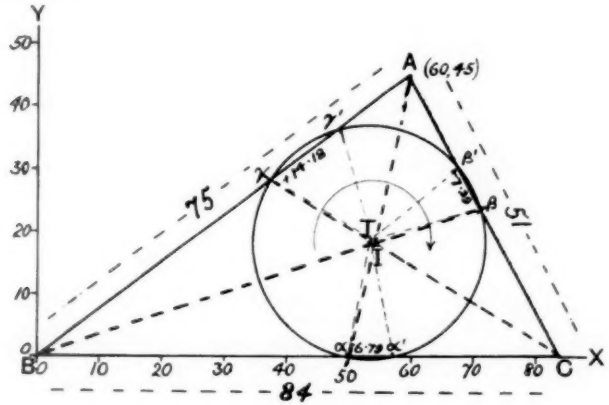

FIG. 8

the other two. Or, if we proceed around the circle clockwise and count a chord + if we meet the bisector first we can say

$$\alpha\alpha' + \beta\beta' + \gamma\gamma' = 0 \tag{16}$$

The longest chord is on the side of intermediate length.

The proof uses two well-known theorems

(1) An angle bisector divides a side into segments whose ratio is that of the adjacent sides, i.e., $B\alpha/\alpha C = BA/AC$

$$\therefore B\alpha/a = c/(b+c) \quad \text{or} \quad B\alpha = ca/(b+c)$$

(2) If secants are drawn from an external point to cut a circle the product of pairs of segments are equal

$$\left.\begin{aligned} &\text{i.e.} && B\alpha \,.\, B\alpha' = B\gamma \,.\, B\gamma' \\ &\text{or} && B\alpha(B\alpha + \alpha\alpha') = B\gamma(B\gamma + \gamma\gamma') \end{aligned}\right\} \tag{17}$$

The rest is algebra. From three such equations as Eq (17) we can prove Eq (16) and by further elimination obtain the absolute values for $\alpha\alpha'$, $\beta\beta'$, $\gamma\gamma'$. For example,

$$\alpha\alpha' = (b-c)\{(a+b+c)^2(b+c-a)-abc\}/\{2(a+b)(b+c)(c+a)\} \quad (18)$$

Thus in Fig 8 which shows the same triangle as Fig 1 we have

$$\alpha\alpha' = \frac{(51-75)\{(84+51+75)^2(51+75-84)-84\times51\times75\}}{2(84+51)(51+75)(75+84)}$$

$$= -6.79$$

Similarly $\beta\beta' = -7.39$ and $\gamma\gamma' = 14.18$

To make a numerical check on a drawing very good draughtmanship and measurement are necessary for the chords cut the sides very obliquely. Take a triangle far removed in shape from an equilateral triangle and see what difference is made whether the $(\alpha\beta\gamma)$ circle cuts twice the actual sides of the triangle or whether the sides must be produced in order to be cut the second time. Another interesting case is that of an isosceles triangle of such shape that the $(\alpha\beta\gamma)$ circle passes through the vertex of the triangle.

JAM HANDY'S NEW CATALOG

New instructional materials to help teachers have just been added to a new catalog issued by The Jam Handy Organization.

The catalog describes 400 class-tested filmstrips in both color and black and white. New kits for 1956 release are described.

The materials, including recordings which are provided with some of the filmstrips, are listed by subject area, for easy reference. Curriculum areas include Reading Readiness, Primary Literature, Music, Health, Science, Social Studies, Nature Study, History, Geography, Arithmetic, Physics, Mathematics, Shop Training, and Safety.

Many illustrations from key frames of the new filmstrips are shown. Prices are listed.

Among the latest releases are Music Stories, in color, recent filmstrip award winners. These are accompanied by long-playing records. Narration is combined with selected musical themes on one side of the records and the reverse gives the full orchestral rendition of the compositions. In harmony with the nationality and theme of the music, each story is visualized.

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SURVEY OF RESEARCH IN COLLEGE LEVEL GENERAL EDUCATION SCIENCE

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This report is a non-technical summary of research in college level general education science for the period August 1954–1955. It is essentially a progress report of the cooperative efforts of the College Level Committee of the National Association for Research in Science Teaching.

Of the 45 journals reviewed, fewer than one half contained studies which could be properly called research; there is an unhappy dearth of significant ressearch in college level general education science. This deficit has been commented upon by previous reviewers of research. At the 121st Annual AAAS meeting, Mallinson and Buck stated:[1]

> Research workers in science education should explore the literature before undertaking studies . . . many studies, even though all established rules were followed with meticulous care, could never have produced other than trivial information . . . research workers in science education should undertake more studies which provide solutions, rather than merely point out more problems, many of which are already known.

Thomas P. Fraser, reporting at the 1955 annual National Association for Research in Science Teaching meeting, commented in this regard:[2]

> The total impact of the research reported in this review seems to indicate a continuing need for: 1) the re-examination of operational definitions of research, and 2) the determination . . . of the real status of research in science education. There seems to be a definite need for motivating a larger number of college teachers to do research in the teaching of science. The limited number of investigations reported for the college level is disturbing, especially in view of the fact that *all college teachers of science are, in a sense, science educators and presumably concerned with the improvement of instruction.* The techniques employed . . . indicate a need for further refinement of the general and statistical methods of such investigations . . . some of these studies appear to be questionable in value, and do not seem to be particularly important when judged by the findings; others were of questionable value.

These comments by Mallinson, Buck, and Frazer are generally applicable to the survey submitted herewith. Research articles of significance in the area of college level general education science are few and far between. The studies analyzed and presented herein are categorized as: 1) studies on the function of the curriculum; 2) studies on the nature of the learning process; 3) studies on the nature and

[1] Georgie G. Mallinson and Jacqueline Buck, "Survey of Research in Secondary School Science Education, SCHOOL SCIENCE AND MATHEMATICS, Volume IV, Number 6, June, 1955, pp. 439–445.

[2] Thomas P. Fraser, paper presented at the NARST annual meeting, Teachers College, Columbia University, February, 1955 to be published in the annual NARST number of *Science Education*, 1956.

organization of the curriculum; 4) studies in testing and evaluation; 5) studies of teacher training; 6) status studies; and 7) experimental studies.

Studies on the Function of the Curriculum

There is a growing belief that educational theory and practice should be in harmony with the social philosophy of democracy. A number of "self-study" programs in certain of the major institutions have resulted in a series of postulations that the chief purpose of college level general education science is to prepare good citizens. There is, apparently, a growing conviction that the fundamental basis of the curriculum is to be found in everyday life experiences, needs, interests, problems, and capacities of students. There is a further trend towards belief that science education, especially at the Freshman and Sophomore college levels, should have social purpose, and contribute to the reconstruction of American life through emphasis on scientific method as a democratic way through which the individual may make the necessary adjustments in a period of rapid and continuing change.

The literature has been replete, for the past few years, with discussions of the need for better general education programs in science and for better specialized programs in science. Numerous opinions have been advanced as to the functions of such general and specialized programs. There has been, however, no systematic attack, via research, on how these general and specialized programs will vary, in function, from previous programs. Much of the current research on the function of college level general education science deals with the nature of the views held by students, teachers, administrators, and "experts." Moreover, little consideration has been given to the present status of curriculum thinking in the area of science education. One fruitful field of research which has been generally overlooked is the careful scrutiny of the dominant thinking current among science educators, as to the function of the science curriculum.

There has been little research dealing with the functions of the program of science education and its relation to the culture. Culture has frequently been viewed as a body of content handed down from the past with certain time honored disciplines, especially science, as its reservoir, with the science teacher as an especial guardian. There is some indication that many science education researchers continue to view the truly educated person as one who is intelligently at home in the various specialized fields of science. There are few researches reported which consider the function of the curriculum as keeping abreast of societal and individual needs; or which postulate the

necessity of a continuous revision of the science curriculum.

Studies on the Nature of the Learning Process

For more than two generations reputable psychologists have repudiated the assumptions underlying "formal discipline" and "faculty psychology." They have reported convincing evidence bearing on the specificity of learning. Nevertheless, a considerable amount of research in science education is based on an assumption that science education is possible on a formal discipline basis.

There is a trend, however, to regard learning as that inclusive development necessary to meet and control life-situations adequately, and that, consequently, the learning experiences provided should be in the nature of real enterprises which call for the exercise of maximal self-direction, assumption of responsibility, creative and scientific thinking, and exercise of choice in terms of desired values. There is, apparently, a decline in the contrary view that science education should demand the give back or demonstration of certain phrases, formulas, skills, and the like which have been memorized or otherwise acquired.

Much of the current research argues that the student should be regarded as an active agent who can be educated only through his own self-directed activity, rather than as so much raw material to be manipulated according to the whim of the teacher. However, a great deal of further research is necessary before this view gains the universal acceptance which its validity merits. Some of the research argues that if it is true that the student can be educated only through his own self-activity (through experience—or doing), then it is obvious that numerous varied, interesting, and meaningful "things to do" should, in large part, replace the reliance on verbalism. Few researches, however, have presented designs for learning based upon a "learning by doing" approach.

The organismic and certain field theoretical views of the learning process have increasingly been felt in most areas of education. However, science educators have seemingly been reluctant to apply the principles of the organismic point of view. To some extent this may be true because acceptance of the organismic view would mean, in part, that students cannot function as though it is possible to acquire a single or given scientific fact or skill without at the same time learning various attitudes. Many science educators continue to preoccupy themselves with striving for a single learning in given situations, thus blinding themselves to the totality of learnings which actually occur. Little research has been conducted in the area of concurrent and concomitant learnings associated with the science

education experience. This is reflected in the trend to attempt to reduce science education courses to sets of principles or concepts which are acceptable to science education experts, and taught on a "cold storage" theory that students should "store-up" facts because they will need them in order to think and act intelligently in the future.

Organization of the Curriculum

Studies on organization of the curriculum continue to be preoccupied with the opinions of the experts as to the kind of organization which should exist. A favorite technique is to review the literature, examine course content in other colleges, present the findings to a jury of experts, and then synthesize a "program" from what is left. Few of these studies deal with the nature of the society, accept recent developments in psychology, or are concerned with the opinions of students or lay persons. Many of the studies on curriculum organization are devoted to enrichment of courses with audio-visual materials, applications from aviation, atomic disintegration, materials of conservation and the like. These studies indicate the possibility of enriching science courses through materials and techniques other than the textbook and lectures. Numerous specific units or courses have been developed, and lists of references and resources presented. With only a small amount of ingenuity, any science teacher who desires, may provide some form of enrichment.

A noticeable trend is the rather prevalent pattern of imitation. Too many of the programs resulting from attempts to re-organize the curriculum begin to assume similar proportions. This may be the result of the well-nigh universal agreement to break science education courses into general and specific aims, allocated to specific courses and college years. This mechanistic conception, together with the practice of defining scope of the curriculum on the basis of the content of the textbook or syllabus and in segmental courses of study, has resulted in a series of course patterns which begin to look very much the same.

Within the past year, however, there has been a noticeable shift to focus on inclusive needs, interests, and purposes of students living in a democracy. The viewpoint presented is that subject matter becomes a means to the end of more abundant living. There have been few researches conducted which conceptualize guidance and instruction as inseparable complementary processes, few concerned with the developmental needs of college students, and few which genuinely support a break with the compartmentalization of science and proposing a broad inter and multi disciplinary approach to science education.

Studies in Testing and Evaluation

Trends in the testing and evaluation of science education programs continue, with a few notable exceptions, to be in terms of subject matter mastery, and retention of the facts of science. Achievement of any given educational enterprise can be appraised only in terms of the goals striven for. A considerable number of studies report a wide range of goals, including attitudes, appreciations, insights, and the like. Consequently, one would expect to find research studies concerned with testing and evaluating to reflect the corresponding changes in the purposes of science education. That this is not the case is evidenced by the dearth of researches concerned with changes in behavior expected to accrue from the science education experience. Most of the current studies are concerned with externally patterned or stereotyped behavior which is no longer considered as valid indices of desired outcomes. A few studies have been concerned with creative expression, and the exercise of intelligence, or application of scientific principles, method, habits, and the like in molding a changing environment in the service of society. A very few studies have been concerned with the individual's behavioral changes as he makes the necessary adjustments to the environment.

Studies in Teacher Training

An increasing number of studies have concerned themselves with the shortage of scientists and teaching scientists. The acute scientific manpower situation in the United States, however, has not generally reflected in the programs for the training of science teachers. Too many science education programs continue to be directed towards the training of research specialists and technicians.

Some studies are reported which are concerned with planning a student teaching program. These studies range from consideration of the use of commercially prepared textbooks, to concern for science subject-matter backgrounds as affects possible success of the prospective science teacher. A number of studies deal with the relative importance of knowledge of science to effective science teaching, the comparative importance of field trips, demonstrations, directed activity, projects, and the like. Several studies dealt with descriptions of changes in behavior which accompanied student teaching and other professional laboratory experiences. Research in teacher education is a welcome sign of increased concern of science educators for improving the quality of the pre- and in-service experiences. Too often, this area has been neglected in the past.

Status Studies

A number of status studies have been conducted which have

ranged from concern as to the status of chemical education in England, the status of general biology in the general education programs of colleges in selected states, to the status of general education programs in the church-related colleges. A few studies have been concerned with the status of science methods courses in colleges and universities, and the status of conservation education in the colleges and universities.

Experimental Studies

Very few experimental studies are reported in science education. Of those reported, several deal with the role and function of the laboratory experience, and how this experience may be improved. These studies indicate that the degree to which laboratory achievment is a function of the number of students working on an experiment is not measurably influenced by the instructor, and may be a function of the number of partners. One study indicated that students working in quartets earn better average grades than students working singly or in pairs; another indicated that grades based on written laboratory reports vary significantly from instructor to instructor, and that scholastic tests are poor and unreliable predictors of laboratory achievement. No studies have dealt with, or been reported, the implications of group dynamics and the group process for science education.

Summary

1. Researchers in science education apparently do not rely upon or adequately use the literature which is available.
2. There is a dearth of significant research in college level general education science.
3. The impact of recent developments in the behavioral sciences, educational psychology and philosophy has not been reflected, as yet, to any considerable extent in science education research.

ANNUAL MATHEMATICS CONFERENCE AT NORMAL, ILLINOIS

The Seventh Annual Conference of the Illinois Council of Teachers of Mathematics will be held at Rock Island, Illinois on Saturday, October 6, 1956. Keynote addresses will be given by Professor G. Bailey Price, University of Kansas, Dr. John R. Mayor, University of Wisconsin and office of Science Teaching Improvement Program, Washington, D. C. and Miss Irene Sauble, Supervisor of Mathematics, Detroit, Michigan.

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A DYNAMIC CHEMICAL MUSEUM

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A new technique or device is suggested to popularize or enhance the teaching of first year college or high school chemistry, or even more advanced phases of the same subject. An attractive and roomy display case or cabinet should be located in the most conspicuous and accessible place in the room employed for instruction. It is then proposed that numerous displays, pertaining to the subject under consideration, should be arranged and used to supplement class teaching. This suggestion is in no way intended to minimize or limit the use of other visual aids, but can rather be used in conjunction with all other available techniques.

It is also realized that many schools or departments maintain displays or collections of a technical nature and these are frequently arranged in well organized "Static" museums. However, too often they degenerate into "dust collectors" or mere assemblies of obsolete equipment or collections of antiquated material pertaining to industrial processes. Various modifications of chemical exhibits, museums and visual aids have been proposed, and used from time to time.

In order to maintain consistent interest and maximum results, it is suggested that displays be changed very frequently as the class discussion progresses. Probably a week or ten days should be the maximum period allotted for any display. Most traditional texts contain a lengthy list of related but distinctly different chapter headings. These same chapter headings are usually used as the basis of class study and discussion, and could well be made the basis for the periodic displays. The extent and complexity of each topical arrangement will necessarily depend upon available space, equipment, time and similar factors. Color and action add greatly to the eye appeal of such a display. If complicated mechanical apparatus is not available, at least a simple turn-table can be arranged with an inexpensive motor and horizontal rotating platform to bring various items into prominence. Certain stock items of equipment will be used consistently. Others should be added as large "+", "=", "ml.", "g.", "cc.", and "l." signs on stable feet. Other similar items will suggest themselves to the ingenious teacher.

Several general recommendations can be made that will apply to a high percentage of the periodic displays. In presenting and discussing the various elements, the same should be prominently displayed. Sources of the various elements or their ores are appropriate. Atomic models of the elements under consideration are desirable. Equations

can frequently be graphically and quantitatively displayed. Salts of many elements can easily be included. Commerical articles that employ the elements or compounds can often be obtained locally. Physical properties, such as color, density or crystalline form, can sometimes be dramatically displayed. Photographs, flow sheets, or diagrams are desirable. Many industrial displays are very attractive and instructive.

Rather than attempt to supply a complete tabulation of suitable topics for display in connection with a traditional beginning chemistry course for use throughout a school year, a suggested outline will be provided for a few typical subjects. It is hoped that these will adequately illustrate the possibilities involved. Likewise, any instructor will vary his approach, depending upon subjects discussed, and type of emphasis placed on each chapter or subject in the course. However, it should be emphasized that the display must be changed consistently to obtain maximum interest and results. Students will frequently, and should be encouraged, to make constructive suggestions. Assistant help or students may be employed in arranging and caring for the dynamic chemical museum. A few typical displays are outlined below.

Water.—An equation representing two volumes of hydrogen and one volume of oxygen to form two volumes of steam and a correspondingly small number of ml. of liquid water can be arranged. Liter flasks or empty acid bottles are convenient containers. Two barometers, one with vacuum and the other with added water, will show the vapor pressure involved. Deliquescent solids will absorb water. A section of iron pipe can be ruptured by freezing. Use the deep freeze if necessary. Electrolysis of water is easily displayed. Arrange an external switch. Evaporate a liter of city water to dryness to show the amount of dissolved solids.

The Gas Laws.—Display various barometers and thermometers. A one gallon can that has been evacuated will dramatically display the tremendous pressure involved. Volumes of reacting gases can be displayed as suggested under "Water."

The Halogens.—Display samples of the four common halogens, and their common salts. Colored cloth, suspended in chlorine gas, will be bleached when moist, but little when dry. Display a bottle of commercial hydrochloric acid. A model of the sodium chloride structure is easily arranged. Many useful organic compounds contain halogens.

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FIVE YEARS OF THE INDUSTRIAL COUNCIL

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INTRODUCTION

During the past few years there has been a great concern with the matters of the decline in the number of scientific and technological personnel graduating from colleges, the shortage of science teachers, and the low enrollments in science courses in high schools. The causes for the problem are obscure although occasionally some glints of light emerge from the claims and postulates that are made on all sides. One fact however does emerge squarely, from all the evidence, namely, that the solution to the problem lies not in the efforts of scientific and engineering interests alone, but in the cooperative efforts of all persons who contribute in any way to the education of these persons, and of the industries that ultimately lure them into employment.

In recognition of these facts American industry has spent over the past few years untold millions of dollars for scholarships, grants, foundations and published materials designed to alleviate the situation just described. However, the results while optimistic, are not all that could be hoped for. Apparently these contributions were being channeled through persons and organizations already interested in science and who were directing their maximal efforts to the attack on the problem.

As a result it was decided to attack the situation from another angle, namely, through the social studies teachers of the United States. It was believed that if the role of American industry could be presented honestly to these persons, they might be able to inform their students more effectively of the place of American industry in our society and its value to our economy and to our way of life. In turn it was thought that this would in the long run influence students to be sympathetic with American industry, to prepare for futures in the industrial field, and to train themselves for that future in the high schools and colleges. The implications for the fields of science, mathematics, and engineering is obvious. As a result the Industrial

Council was formed. It should be stated here that the aims of the Industrial Council transcend the problems described above. However, a report of this organization and its activities will indicate the extent to which the problems of science and technology are being aided.

The Development of the Industrial Council

The Industrial Council was founded in 1952 as a non-profit educational organization sponsored jointly by Rensselaer Polytechnic Institute of Troy, New York and American Industry. It functions under a Director, James H. Liberty, whose headquarters are located at R.P.I. He is aided by a General Chairman, who is Chester H. Lang, a retired Vice-President of the General Electric Company and a Consultant who is Ray Palmer Baker, Vice President Emeritus of Rensselaer Polytechnic Institute. The annual session is managed by the persons named above, together with a small staff of full-time assistants, certain faculty members of Rensselaer Polytechnic Institute and a number of special committees. These committees include a General Committee, an Administrative Committee, a Program Committee, a Committee on Exhibits and Literature, a Ways and Means Committee, a Reception Committee and a Committee on Local Arrangements, the chairmen and members of which constitute a "Who's Who" of American Industry.

At this time the reader may question the naming of such a variety of committees and wonder why so many are needed to run a single session. The writer has attended a number of these sessions and wishes to report that each session is an enterprise of staggering proportions, one that is most difficult to imagine unless one attends.

Each year a three-day session is held on the campus of Rensselaer Polytechnic Institute during which a particular branch of American Industry is the subject of discussion. To date five sessions of the Industrial Council have been sponsored respectively by the Oil Industry, the Chemical Industry, the Electrical Manufacturing Industry, the Automotive Industry, and the Pharmaceutical Industry. About 650 teachers of social studies in the secondary schools have been invited as guests to attend these sessions at which representatives of the various industries have discussed their activities. These teachers are selected by the Commissioners of Education and local superintendents of schools from all the forty-eight states as being leaders in the field of social studies in the secondary schools. A new group is invited to each session except for about ten percent who are reinvited at the discretion of the Industrial Council in order to maintain some continuity. In addition to these teachers and the industry representatives, a number of educators from areas of educa-

tion other than social studies are invited to participate. The combined attendance is over one thousand.

The Industrial Council has ready for each participant at registration a check covering his transportation expenses to and from the meeting by whatever conveyance he chooses. He is met at his point of arrival, taxied to the hotel to which he is assigned, provided with his meals, given transportation to and from the meetings, and finally taxied to the point at which he makes the return trip. All expenses and all arrangements other than transportation to the home transportation terminal are handled by the Council. The magnitude of such arrangements, considering the limited hotel accommodations in Troy and neighboring Albany, can be readily understood. As a participant at the meetings, the writer has not yet heard of one "slip-up." Some may have occurred, but if so the lack of comment indicates their minor nature. Truly the efficiency of industry is reflected in the dispatch with the arrangements and activities progress.

The Meetings at the Sessions of the Industrial Council

In general the first day session begins in the afternoon with a guided tour of a local industry and an informal reception in the evening at one of the local hotels. Here the educators who arrive early chat informally with the representatives of industry. It is most difficult to distinguish "who is who." A social studies teacher from a town of 1,000 could well be rubbing elbows with the president of a major chemical company. The effect on the teachers has been noted readily by the writer. The common concerns of both educators and industrialists with the role of industry, science and technology in the American economy is quickly apparent.

After registration the next day, and for the remainder of the Session, the same general pattern of activities is evident. After a luncheon some representative of industry makes a major address such as, "The Pharmaceutical Industry . . . Its Contributions to Health," "How the (Electrical Manufacturing) Industry Began," "The Automobile—Servant of the People," "The Chemical Industry and the Future," and "The Financial Background of the Oil Industry."

The participants then go to panels or conferences to which they have been assigned. Here a panel of both educators and industrialists discuss briefly aspects of the major address and the audience is then allowed to question the panel members. Ordinarily four major addresses with the corollary panels are held.

No effort is made to restrict the type or extent of questioning. In general the response is made by the panel member most closely allied to the area with which the question deals. During the Council

Sessions one factor is noted. If no one has facts to answer a question, it is so stated. In the earlier sessions both educators and industrialists expressed opinions which in one or two cases proved embarrassing. The statement, "I don't know," is now heard in such situations.

During his attendance at these sessions the writer has never heard one panel member try to avoid making a response or give a dishonest one. The frankness at the sessions is indeed refreshing.

The final session held the last evening involves a summation and a look to the future.

The writer, as a participant, has believed these sessions to be of inestimable value to the causes of both teaching of social studies and and science, to the shortage of scientists and technologists, and to better relations between industry and education. In a way he wishes some technique would be used to measure the outcomes of the Sessions and in a tangible way justify the expenditure of the great sums of money. It is a successful activity and he believes that the industry should know it.

What the future of the Industrial Council will be is not within the knowledge of this writer. Yet, because of the evident success of past Sessions, he hopes that other industries will "speak their piece" in the future.

PHYSICS APPOINTMENTS AT CARNEGIE TECH

Two Canadian-born physicists whose careers have travelled the same path since boyhood were named to the top Physics posts at Carnegie Institute of Technology.

Carnegie President Dr. J. C. Warner appointed Dr. John G. Fox, head of the Department of Physics and Dr. Roger B. Sutton, director of the Nuclear Research Center at Saxonburg. The Center is a function of the Physics Department. Both positions were formerly held by Dr. E. C. Creutz who resigned in November 1955 to join the General Dynamics Corporation.

Both Fox and Sutton were born in Saskatchewan, Canada, received bachelor's and master's degrees from the University of Saskatchewan and their doctorates from Princeton University.

In 1946, both physicists joined the Carnegie Tech faculty as assistant professors after serving as research physicists at the Los Alamos Laboratories, and in 1949 both were advanced to associate professors. In 1950 Dr. Fox became assistant head of the Physics Department and Dr. Sutton became assistant head of the Nuclear Research Center. Both were appointed to the executive committee of the Nuclear Research Center in 1953. After the resignation of Dr. Cruetz, the two scientists took over his duties, Fox as acting head of Physics, and Sutton as acting director of the Nuclear Research Center. Now President Warner has appointed them head and director.

Between them, Doctors Fox and Sutton have collaborated on eleven publications in the field of nuclear physics in addition to their individual contributions. Both are married and each has two children.

MICHIGAN'S WILD ANIMALS—THEIR HOMES AND HABITS

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"How did this worm get into my apple?" "What will happen to the ants when the snow is on the ground?" "How long does it take a deer to grow its horns?"

Do these questions sound familiar? Of course they do, because universally children are interested in animals. The subject heads the list of their interests. Hence, wise teachers of science will begin planning here. Obviously, one must build upon the background and experience of the group at hand. And rare, indeed, is the fifth grader who has not had contact with bird nests and ants, worms or frogs. From the well known, the instructor goes into the less familiar, but never completely beyond their environments. With these points in mind, a good instructor can develop a fine science unit dealing with animals.

Children have basic emotional and physical needs—needs that a unit on animals may satisfy as it develops. Briefly, they are: (1) a necessity for achieving self-realization and self-assertion, followed by recognition, (2) the need for exploration and mental investigation, (3) the desire for physical activity, (4) the need for association with peers, (5) opportunity for an outlet for imagination, and (6) provisions for effective learning. An attempt will be made here to develop a unit that satisfies such needs.

Actually, one might say that such a unit is one of muliple choices. No two groups who may use it are the same. Their environments vary. Their states of readiness, while similar, will be at various stages, and the youngsters themselves vary within the same group. Needless to say, the material to be collected by the teacher for study will be selected to meet the specific topics under investigation. And, there is no lack of reference material. In fact, the problem becomes one of wise selection. Care must be given to the soundness of the factual content.

The main concern of this writer is that the unit be taught with a contagious spirit—a spirt of approbation, a feeling of fondness for the subject at hand. One is told things are caught, not taught. That is why it is strongly urged that some oral reading by the teacher accompany this study. Virginia Moe's *Animal Inn*, published by Houghton Mifflin Company is an excellent choice. *True Zoo Stories*, by William Bridges, published by William Sloane Association, or *The Animals' Christmas*, by Ann Thaxter Eaton, published by Viking, are other possibilities that will help to develop interest and spontaneity on the part of the student.

To conclude, it may be summarized by saying that the teacher must know and understand the basic needs of this age level. She must present the project in a vital and challenging manner. She must allow the students to take part in the cooperative planning based on some pre-planning by the teacher. Together, they should carry on some meaningful and purposeful activities. This must be followed by evaluations both by the teacher and by the students. Finally, the teacher must provide for opportunities in which the new learning will be used.

This is quite a recipe for anyone to follow, and however skillful the cook, it must have some real "ginger" added to make it lively, and a dash of something on the top for color and sparkle.

UNIT

Name: Michigan's Wild Animals—Their Homes and Habits

Grade Level: Fifth Grade

Time: Approximately two months in duration, to begin in the early fall. It is estimated that an average of two to three hours per week is sufficient. The time would vary greatly, however, depending upon the degree of integration of material into entire curriculum, and upon cooperation of "special" teachers, such as art and music.

Materials: For the purposes of this unit, it is assumed that there will not be one textbook for the year, but rather a classroom library of several copies of three or four series of elementary school science books, plus as many other supplementary books as the teacher deems advisable. It is recommended that they be changed from time to time, so that new ones are added, unless popular demand proves too great for certain ones.

Objectives:

Primary: To help the student become more appreciative and understanding of his own immediate environment, and the wild creatures within it.

Secondary:

1. To help the student develop his ability to observe and describe the homes of wild animals in terms of his own level.
2. To develop within the student the ability to detect similarities and differences between different classifications of animals and their homes.
3. To help the student see a relationship between the kind of animal and the type of home built.

Motivation:

First Day: Bulletin board display as youngsters arrive in the morning. This should be pictures of as many different animals and their homes as can be displayed effectively.

Second Day: Appearance of science table. Upon it should be an empty aquarium, a bird's nest (be sure to treat it for lice), a wasp's nest (minus any wasps), and/or any other vacated home of local animals or insects.

Third Day: Teacher should bring in an ant hill that has been collected in a large glass gallon jar (wide mouth). Directions for acquiring such a hill are found in Turtox Service Leaflet, No. **35,** published by the General Biological Supply House, 8200 South Hoyne Avenue, Chicago, Illinois. Also, in the following sources: *Exploring Science*, Book 5 Teacher's Manual, by Walter A. Thurber, published by Allyn and Bacon, Inc., page 26. *Methods and Activities in Elementary School Science*, by Glenn O. Blough and Albert J. Huggett, published by The Dryden Press, page 175.

Or—A beehive may be borrowed from a local beekeepr. It should be attached outside of the window so that the children are protected as they watch.

Or—Wood with termites can be located in the woods and a section brought into the classroom. Often local exterminiating companies will be happy to supply such an exhibit.

On a second table or in a bookcase (table is best) some carefully chosen books are displayed. These should be especially appealing.

Discussion:

On the first and second days the teacher does not call any attention to the board or exhibits. If questions are asked by the students they should be answered enough to satisfy them temporarily.

By the third day enough enthusiasm should be generated and questions multiplied to the point that discussion should "burst at the seams." The teacher may say, "Well, now let's see, some of us have many questions. What can we do about it?" The only answer is investigation. "Where?" "That's right, we have some books here." "Yes, pictures, too."

And so it comes out, all the places that the students might find an answer to their queries, the library, dad, mom, perhaps a book at home. "The outdoors?" "Why, of course," says the teacher. "What better way can we observe animals in their homes, than by going to where their homes are located?" The time and place are not set yet, because the teacher knows some more planning is necessary. But the the prosepect of a hike spurs the group on to more discussion and questions.

"Perhaps we ought to take a day to think this over, and decide what we want to know. And maybe some of you have some examples of animals and their homes that you would like to add to our exhibit."

So here ends the third day.

The next day or two may find some additions to the science table —perhaps a gold fish, maybe a white rat. Everything should be gratefully received if it can be fitted into the general theme, because it is an indication of interest and contribution to the common effort.

A list of questions are asked, and gradually it can be seen that all are not interested in the same animals. So committees are formed, four to six each. Interests are determined and work starts, work which may go on for two or three weeks. There will be, without doubt, some who want to investigate insects, water around ponds, and life within the woods. Now is the time to plan the field trip to the local area wild life reserve. It could be pointed out that the empty glass case can become a terrarium or aquarium. Needless to say, several will want to use it. Two things should happen: First, the stocking of the room container will involve the cooperative efforts of the groups. Second, other youngsters will obtain large-mouth glass gallon jars to make their own collection. Such jars are entirely satisfactory, and no one will be denied private possession if he needs that emotional security at this point, or, if the interest of one individual exceeds that of the group. These containers may be obtained by the children from eating places.

Groups should be given adequate time to work together, and it is understood that a sharing and pooling of knowledge will take place. The teacher must watch carefully the interest span of each one. When there is a slowing down of accomplishment, as there is bound to be, then it is time for a reorganization. Probably the entire group should work together for a few days while some general summaries are made. The first issue of a composite report could be readied for typing and duplication at this time.

A complete regrouping could be effected in a few days. The same general procedure should be followed again, unless experience showed another method to be more practical. Topics investigated by the individual groups might be the same as before, or they may follow new ones chosen from group discussion.

If this unit is started in early fall, Thanksgiving is about as long as it should continue. However interesting and challenging to some, the majority would be ready for something new.

As the activities proceed care should be taken that the new knowledge and skills are well integrated. When it is learned how to care for the terrarium, a follow-up should come. Is it actually being done? What happens when it does not have enough water? Is the pet raccoon, or are the white mice getting enough food? Is it the right kind? "There were many robins on my lawn this morning. I wonder why since they do not habitually live in a swarm?"

These are only sample questions, but serve as a guide for the kind of thing that must be done.

It already has been mentioned that some kind of a final report could serve as the culminating activity. A written paper in which the actual work of the students appears would be a good possibility. In addition, an exhibit in a hall showcase might be arranged, along with art work, or other activities which have been related to this unit.

This brings the discussion logically to the topic of the fusion of this study with the other schoolroom work. It would be possible, of course, to center the entire work day on the subject of animals. However, this is questionable for this age level. In the first place it takes a skillful person to follow such a method, plus the fact, that often too much of one thing makes for lack of emphasis and highlight in the mind of the youngster.

Some words can be added to the spelling list, words that they are using and need to know how to spell in order to write the final reports. Grammar and construction would be a part of the culminating activity, also. Oral expression cannot be taken away, so it can receive attention.

Early in the development of the unit the library shelf or reading table would contain books of fiction connected with the topic. The wise teacher would read poetry about animals, not just in the period labeled "Poetry," but whenever the time seemed right. Time should be allowed, too, when reading aloud would be in order—a time when the youngsters could be relaxed and informal.

The music of the grade at this point could include animal themes, both for appreciation and for singing. And excellent opportunities are present in art. Here models can be made of clay, pictures may be drawn. Activities may be followed in almost any medium. The alert art teacher can do much to develop observation, and sense of size and proportion. As animals are drawn with scenery around them, care should be taken to adhere to scientific accuracy. The possibilities are limitless.

The unit should not be put away until there is a final evaluation on the part of both the teacher and the students. Has there been an increased awareness on the part of the students of their immediate surroundings? Are they able to observe animals with a degree of appreciation of their habits, the regularity with which they function? Have they developed their ability to check for scientific accuracy? Can the student see the fundamental differences between man and the wild animals? Does he see that man behaves as he does because he has the power to think and reason, and that the actions of animals are based on instinct?

The following lists are not in any sense complete because possibilities are endless. Much material will need to be collected. Books, pamphlets, pictures, filmstrips, movies and records are only a few suggestions to enrich the presentation of the unit. What choices are made by the individual teacher will depend to a certain extent upon what is available. Experience will determine which ones are of the most value, and what others should be avoided if the unit is done with a second group.

General Questions Arising from Discussion:

1. Do animals live in a community like people?
2. Why do some animals live alone and others together?
3. If animals live near each other don't they live together?
4. Who lives underground?
5. Why do birds travel so far?
6. What insects are useful to man?
7. In what places do animals make their homes?
8. How do they make their homes?
9. Out of what things do they make their homes?
10. Do the parents teach their offspring to make homes?
11. How much of the year do animals stay in their homes?
12. What is the difference between warm-blooded and cold-blooded animals?
13. For what purpose were flies put on the earth?
14. What different kind of spiders are there?
15. Is an ant the strongest animal in the world according to its size?
16. Do butterflies have four wings?
17. How do caterpillars make cocoons?
18. How can fish and some other animals stay under water?
19. Do ants live in towns?
20. How do worms get in apples?
21. What effect does the change of seasons have on the homes of animals?
22. Why do animals live in herds?

Possible Divisions of Animals for Group Study:

1. Animals that live in trees.
2. Animals that live underground.
3. Animals that live in water.
4. Animals that live around water.
5. Animals classified according to kind of body.
   (a) no bones
   (b) soft body inside—hard coverings.

(c) soft bodies with no hard shell
6. Animals who are warm-blooded.
7. Animals who are cold-blooded.
8. Mammals
9. Animals that hibernate.
10. Animals that hibernate only part of the time (chipmunks).
11. Animals that travel long distances.
12. Animals who live alone.
13. Animals who live in groups.
14. Animals who go about in herds.
15. Animals who are together for sleeping and eating.
16. Animals who are friends to man.
17. Animals who are man's enemies.
18. Animals who are parasites.

Suggested Activities: Not all of these can be done by any one teacher. Use only those that will be practical and beneficial to the group, depending upon direction of individual interests.

1. To find out who lives around a certain area. Find a large stone or a stump of a tree and put some bait (food) on top of it. If possible, it should be surrounded by soft sand or dirt, something which will make it smooth and quite firm. Scatter sifted ashes around on all sides wide enough in diameter to get good impressions of animal tracks. By examination within a few hours or in the following morning and identification of the tracks, it can be determined who are some of the inhabitants of the vicinity.
2. Field trip to local area wild life reserve. This should be a two or three hour trip, perhaps even all day, with the youngsters taking a sack lunch. Specimens should be obtained for school. It is necessary to acquire knowledge of animals' natural requirements before hand, such as temperature, moisture, light and food, and to try to reproduce them, so that they may be properly housed.
3. Publication of a room newspaper, an animal bulletin ("Paw Prints") or some composite report that could be typed and duplicated so that all may have a copy.
4. Visit to local Bird Sanctuary. The Bird Group could initiate this trip. It might involve writing a letter to the director. (Fusion of subject matter.)
5. Contact local conservation officer to find out what is being done to protect Michigan's wild life.
6. Visit a local fish hatchery.

7. Watch "Michigan Out-of-Doors," a television program. Reports on interesting facts.
8. Watch bees making a beehive outside of the classroom window.
9. Book reports in the form of a digest for the room newspaper.
10. Games, based on identification, such as Bingo. (Made by children.)
11. Viewing movies and filmstrips.
12. Learn bird calls and animal sounds from records.
13. Build an animal feeding station to put outside of classroom window.

Vocabulary: These are only samples. Specific words would be determined by groupings picked by students.

1. hibernate
2. swarm
3. food chain
4. social group
5. adapt
6. terrarium
7. aquarium
8. specimen
9. amphibian
10. reptile
11. conservation
12. aquatic
13. breeding
14. algae
15. species
16. migrate
17. periodic
18. chrysalis
19. larva
20. pupa

It can be seen how children may study a unit on animals starting from their immediate environments, the school ground and their own back yard, areas in which they feel completely at home. Questions, self-initated problems, followed by interest and investigation will lead them into broader horizons, but still within their reach. The environment surrounding them will take on new meaning and significance because creative teaching in its real essence will have taken place.

SOUTHERN CALIFORNIA MEETING AAPT

The fall meeting of the American Association of Physics Teachers, Southern Calif. Section, will be held October 13, 1956, at the California Institute of Technology.

Drafting Pen draws a continuous line, one millimeter thick, for 700 feet without refilling. Of West German design, the pen uses rubber based, India or colored inks or water colors. It is capable of producing line thicknesses ranging from .1 mm. to 2.8 mm., according to the nib selected. Blotting is eliminated.—Quality British Corporation, 120 Liberty St., New York 6, N. Y.

AVIATION IN OUR HIGH SCHOOLS

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HOW DO WE STAND?

In 1947 the American Council on Education and the Civil Aeronautics Administration published a book in which they reviewed the nature of courses and teaching methods in high school aeronautics. Their conclusions were most optimistic:

> . . . the educational interests of the country, that is, the schools, the teacher-training institutions, the editors, the professional associations, the textbook publishers, and, in this case, the industry, have done a masterful job in bringing aviation education to the boys and girls of school age.
>
> . . . In 1943 a survey indicated that approximately one-half the high schools of the country were providing courses in the science of aeronautics. . . . We cannot, therefore, accuse education of lagging in adopting aviation. On the contrary, we believe the record of the schools is an outstanding example of a social organism consciously adapting itself to a changing world.[1]

What is the picture today, more than a decade later? Have we progressed sufficiently to boast two-thirds or three-fourths of our schools presently offering aviation education? Unfortunately our "progression" has been in the opposite direction.

During the school year 1954–1955, we conducted an extensive survey involving the secondary schools of New Jersey. While New Jersey may not be representative of the entire country, it boasts of being one of the leading states in the field of secondary education. New Jersey leads California and the District of Columbia in expenditure per pupil for full-time, public elementary and secondary schools, and trails only two states (Oregon and New York) in this department. Nationwide, New Jersey ranks seventh in average annual salaries to the teachers, supervisors, and principals of its public schools.[2]

Of the 176 secondary schools of New Jersey, only *five* offered full-time, 5-credit aviation courses, with one offering a half-time, 2½-credit course. In contrast, during the years of World War II, fifty-one New Jersey high schools offered full-time aviation courses.

IS AVIATION A WAR-TIME COURSE?

The foregoing figures might, at first glance, lead to the conclusion that aeronautics in the public high school is primarily a war-time course, bound to disappear with the advent of peace. However, such was not the case.

[1] *Teaching Aeronautics in High Schools*, American Council on Education and Civil Aeronautics Administration, pp. ix–x.

[2] *Statistics of State School Systems*, Office of Education, pp. 14–23.

REASONS FOR DISCONTINUING AVIATION COURSES IN FIFTY-ONE NEW JERSEY HIGH SCHOOLS AS GIVEN IN QUESTIONNAIRES, MARCH 1955[3]

Reasons*	1	2	3	4	5
Number of Schools	14	6	17	2	12

* 1. Staff member qualified to teach aviation left school
2. Crowded conditions
3. Lack of pupil interest
4. Lack of facilities
5. Lack of interest on the part of the board of education

The reasons given for discontinuing high school aviation courses in New Jersey were somewhat significant in that crowded conditions and lack of facilities were not major factors.

The most requently stated reason for cancellation of aviation courses, "lack of pupil interest," was questionable, especially in light of the two next most frequently stated causes, "staff member qualified to teach aviation left school," and "lack of interest on the part of the board of education." I have yet to meet a group of high school students "not interested" in aviation, providing adequate stimulus, in the form of an enthusiastic teacher trained in aeronautics, is present. Bearing in mind that the figures of this report were obtained entirely by the questionnaire method, convenience of checking an item which places the blame not on one's own shoulders must be considered here.

Nonetheless, of considerable significance is the fact that of the six schools currently offering aviation courses, three initiated these courses *after* the conclusion of World War II. Although three is an extremely small number, it represents 50% of all the New Jersey schools offering aviation courses in 1954–1955. It must therefore be concluded that aviation offered in high schools in 1955 was not solely the result of "left-over" war-time courses.

IS HIGH SCHOOL AVIATION WORTHWHILE?

Those who accept "life adjustment" as the overall purpose of education must agree that whatever affects society will necessarily affect the schools' curricula. Aviation affects producer and consumer, distribution and communication, and the conservation of human and natural resources; it points up interracial, intercultural, and international tensions. Because of these widespread effects upon areas of common interest, aviation offers countless vocational opportunities.

Over three million people are currently employed in aviation fields, ranging from transport dieticians to electronic engineers. As

[3] Joyce M. Placek, *The Status of Aviation Education in the Secondary Schools of New Jersey*, p. 50.

the consumer use of aviation's facilities expands, it logically follows that job opportunities in aviation will increase. The C.A.A. summarized aviation's educational implications in this way:

> In this business of teaching, regardless of the aspect we consider, the student must be brought to face the future. . . . Our schools cannot remain miniature ivory towers . . . every significant implication that aviation and kindred developments hold for society must be recognized in educational practices.[4]

The three-phased application of aviation education for high school students—pre-induction training, vocational opportunities, and recreational pursuits—demands reflective examination of the contribution our secondary schools are making in this direction. Indeed it is a field we cannot *afford* to neglect.

But, it may well be asked, is it the duty of public schools to offer such specialized training? Specialized, indeed!—Aviation is one of the very few high school courses which may truly be called *applied* science. It is, in fact, a course in physics, meteorology, trigonometry, algebra, chemistry, social studies, radio, engine mechanics, and aerodynamics "all rolled in one" and applied to that which fascinates youth. There seems to be no other single high school course wherein the students master so many difficult scientific principles with comparative ease—merely because, by applying these directly to air age concepts, youngsters are intrigued and *want* to learn.

What Is the Answer?

High school aviation education today is more vital than ever before, and yet it is shamefully neglected. There is now not a single, major world-power which is not far ahead of the United States in preparing its youth to adapt successfully to the aircraft era which is upon us. 56.2% of New Jersey secondary schools offer no aviation at all; the other schools offer a range of from four to twenty periods of aviation per *year* divided among their general science, physics, and senior science courses.

"Lack of pupil interest" is not a valid reason for eliminating aviation from out schools. It seems, from our findings, that this serves better as a "comfortable" excuse for our educators, rather than an absolutely candid reason. However, even accepting it at face value, if our curricula were based solely on pupil interest, would worthwhile courses such as Latin and geometry have survived this long?

The true answer to this problem of decreasing aviation education seems to lie with the teachers; and hence, ultimately with our teacher-training institutions. More than one-fourth of the schools which cancelled their aviation courses after 1945 were forced to do so because "the staff member qualified to teach aviation left school."

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[4] *Aviation Education*, American Council on Education, p. 16

It was indeed shocking to learn that more than *three-fourths* of the 129 science teachers currently engaged in giving aviation instruction to high school students in New Jersey have had absolutely no preparation in the field of aeronautics. Of those teachers who have had some preparation for aviation teaching, less than one-half of them received formal training at a college or university. In contrast, every one of the teachers giving full-time aviation courses have had at least four semester hours of college work in aeronautics.

It seems not unreasonable to conclude from these and other findings of our study, that aviation would be more widely offered in the State of New Jersey if the science teachers were better qualified to teach it.

Where Do We Go from Here?

Since a major part of the blame for lack of aviation education rests with our teacher-training institutions, it seems well to examine their current practices. At present, a student can graduate from any of New Jersey's teachers colleges with a major and a minor in science without ever having had *any* aviation. Aviation courses, *when* offered (once every three or four years), are primarily at the graduate level.

It is almost an anachronism that we spend precious college semesters running the scientific gamut from astronomy to geology with our undergraduates, while completely ignoring one of the most timely of all sciences, aviation.

The answer, then, appears obviously simple. We must offer—better yet, require—at least one semester of aviation for all undergraduate science majors and minors in our teacher-training institutions. And, as is the practice at the New Jersey State Teachers College at Montclair, each science student while taking the aviation course should be afforded the opportunity to fly, and handle the controls of a light plane while in flight. Then, and only then, would we be assured of future science teachers not only qualified, but perhaps more important, enthusiastic and dynamic in presenting aeronautics to our high school students.

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EXPLAINING ABSTRACTIONS TO HIGH SCHOOL SCIENCE STUDENTS

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We want to make each student use his imagination, because we want him to understand and conceptualize, rather than merely to learn facts. The more wonder the student experiences in connection with scientific discoveries—the more he stands in awe of reality—the more likely he will be to attempt to understand and to delineate these problems with his intellect. Ideally, we want the learning of science to be the kind of experience which, at moments, actually releases the mind of the individual from his own egocentric cravings, and makes him see beyond the limits of his own experience. This is especially true today because so much of modern science goes beyond the realm of sense experience. Briefly then, we will need to have at our disposal some teaching techniques which appeal directly to the imagination.

In a sense, this kind of teaching might almost be considered an exercise in applied poetry. Like the poet, we will be using certain sensory images to convey both an abstract idea and an experience at the same instant. T. S. Eliot once said that the Elizabethan poets "had their intellects at the tips of their senses." Let us see if we can show how this technique of communication can be applied to teaching science.

We will be applying this technique if, in teaching or explaining abstract scientific concepts to our students, we make use of sensory images which are spectacular, which convey both thought and experience, and which consequently stimulate the student to conceptualize. Explanations containing such images would have a greater and more lasting impact on the student's mind than the sort of straight-forward, discursive prose one finds in most text books. What images, specifically, could we use to these ends?

Example #1

Suppose we were teaching the atomic theory to high school chemistry students, and we wanted to make it clear that there is a great deal of space inside the atom—empty space between the nucleus and the various orbital electrons. We might bring home the point with the following statement.

"If you could collapse the atom—so that there were no longer any space inside of it—and if you could collapse every atom of which the

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The drawings were made by Charles Martens.

Empire State Building is made, the Empire State Building would shrink to the size of an ordinary needle. And this needle would still weigh as much as the Empire State Building weighs. If you dropped it on the ground, head-first, it would go right through the earth and come out the other side."

One of the stronger motivating forces behind many of our scientific endeavors, especially in the realm of theory, is the "escape" into the imagination that science sometimes offers. Fantasies such as the above invite the use of the imagination at the same time that they enable the student to conceive of realities in vivid terms. When this happens the student will also "see" the world through a new pair of eyes.

Example #2

Suppose you want to make the student realize, in some very empirical way, just how small a molecule is, and how many molecules there are in a mere cubic inch of matter. You are dealing, of course, with sizes and numbers that are way outside of the realm of ordinary human experience. Your aim is to bring them into the realm of experience by way of the student's imagination. The following statement illustrates this process.

"Let us imagine that we have one cubic inch of red dye, and we drop this cubic inch of red dye into the Pacific Ocean. We then wait until it spreads out through the entire Pacific Ocean and spreads throughout the entire Atlantic Ocean too. Then we take one cubic inch of ocean water from any part of the Atlantic or Pacific Ocean. This cubic inch of ocean water will still contain about a million molecules of red dye."

Another fantasy of the same type might be the following: "If you had one cubic inch of table salt, and you were suddenly able to increase the size of each salt molecule to the size of a grain of sand, you would then have enough salt to go all the way around the earth six miles deep."

Example #3

Frequently, in a science course, the question of what it means to be objective comes up. What is objectivity, what is the scientific attitude, and what are the limits of scientific knowledge? There is an ancient Chinese anecodote which illustrates, in a rather colorful way, the fact that objectivity is always limited, and human knowledge itself is limited—that we can really only be certain of that which we perceive, and sometimes not even of this.

"A Chinese philosopher, centuries ago, dreamed one night that he was a butterfly. The dream was very vivid. He flew about in the

fields, he felt like a butterfly, he even saw his butterfly reflection in a pond. When he finally awoke in the morning and found that he was not a butterfly after all, but a human being, a strange feeling of uncertainty came over him. How can I be sure that I am a man, he wondered. Perhaps I am really a butterfly dreaming of being a man!"

Example #4

One cannot possibly form a mental picture of four dimensions. Our experience has been entirely with three dimensional figures, or two dimensional designs. But even though one cannot conceive of four dimensions directly, one can form some idea of a four dimensional configuration indirectly. Here is one way of explaining it to students.

"Architects often have to project three-dimensional figures on to paper, and in so doing they diagram these figures in two dimensions. For example, if you wanted to make a two dimensional projection of a cube, it would look like a square inside of another square, with the vertices joined, as shown in Fig. 1a.

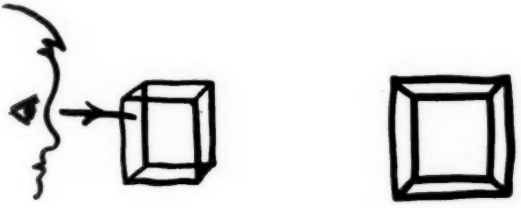

FIG. 1a. A two dimensional projection of a cube.

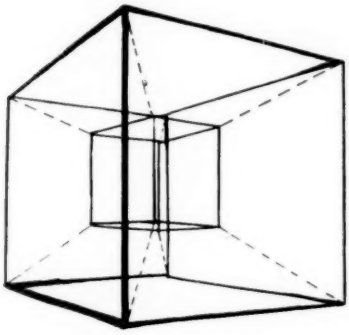

FIG. 1b. A three dimensional projection of a four dimensional figure.

"If a square inside of a square represents a two dimensional projection of a three dimensional figure, then perhaps a cube inside of a

cube is a three dimensional projection of a four dimensional figure!" See Fig. 1b.

Example #5

Professor Grantham, of Cornell University's physics department, had a number of teaching tricks up his sleeve that none of his students will ever forget. Although they were demonstrations, rather than images, they were used toward the same end as the images we have been considering. The one that stands out in most people's minds is the pendulum demonstration. His pendulum consisted of a steel ball weighing perhaps fifty pounds, hanging from a wire about a hundred feet long. Standing at one end of the enormously high-ceilinged room, he held the ball one inch from his forehead, as shown below.

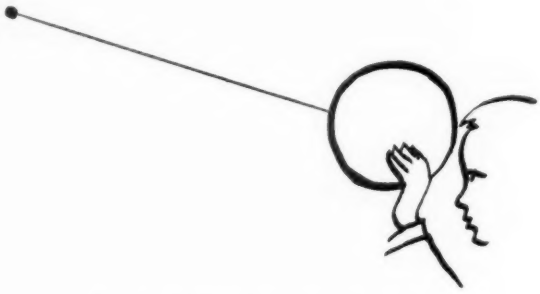

FIG. 2. Professor Grantham's pendulum.

He then let it go and of course it swung across the room and back at a very high speed. Several students in the lecture hall screamed as the fifty-pound steel ball zoomed back toward Professor Grantham's head, for had it hit him it might well have killed him. But the ball stopped about an inch from his forehead, as the more sophisticated students could have predicted! Nobody missed the point of the demonstration, namely, that the arc of the pendulum decreases slightly with each swing.

Example #6

The French biologist, Fabre, did an amazing experiment with ants which has since been repeated a number of times and put on movie film. The experiment raises the question of instinct versus intelligence in the behavior of lower animals, and it gives the student an idea of how surprisingly complex and seemingly ingenious some instinct behavior is. Like the various images discussed, it provokes a great deal

of wonder and thought on the part of the student, and it can easily be described to a high school class.

Fabre took some ant eggs and put them on top of a small mound of dirt. Around this mound of dirt he poured water, so that the effect was that of a hill in the middle of a miniature pond, as shown below.

The ants which had layed these eggs remained on the "shore" of the pond, and near them were all kinds of twigs, pieces of leaves, grass, etc. Within a short space of time, the ants went frantically to work. Organizing themselves as efficiently as any army engineering contingent, they erected a bridge across the water, using the leaves and grass and twigs. Then, one by one, they crossed the bridge, picked up several of the eggs, and brought them across to dry land. In less than twenty minutes all the eggs were safe on dry land. Ants will instinctively protect their eggs from water which kills these eggs. No obstacle can discourage them from this course of action.

FIG. 3. Fabre's experiment with ants.

The question then arises, is this instinct or intelligence? It would almost seem as if the ants stopped and thought to themselves, "There is a possibility that these eggs will get wet. If they get wet they will die. The species must survive. Therefore we must erect a bridge and carry the eggs to dry land."

Could something this ingenious and complex be attributed to instinct and to automatic reflexes in their nervous systems? The answer, of course, is yes, because the ants had no other choice but to do exactly as they did. They could not possibly have refrained from building the bridge and carrying the eggs to safety. They did it automatically. It was not a conscious decision, and therefore it was not intelligent behavior.

Example #7

To understand evolution it is necessary to understand the proposition that if time lasts long enough everything conceivable will eventually happen. This is merely a corollary of the law of averages. Mutations and new combinations of hereditary traits occur by chance all the time. The longer the period of time, the greater the number of hereditary changes that occur. Consequently the enormous variety

of forms of life on the earth today must be seen in relation to tremendous lengths of time. This concept can be presented in the following way.

"Let us assume that we have six monkeys who are capable of living forever. Let us assume that we seat these monkeys in front of six typewriters and allow them to tap away at random on the typewriter keys. At first their papers will probably make no sense at all. They will merely be a jumble of letters and numbers and punctuation marks. After a while, however, the chances are that some of these monkeys will have written out English words, and spelled them correctly, by sheer mistake or chance. As time goes on, we may even find, among the thousands of papers, whole English sentences which happened to appear because there were so many combinations of letters struck at random. If time lasts long enough—after billions and trillions and quadrillions of years—the chances are that at least one of these monkeys will sooner or later type out the entire Encyclopaedia Britannica and The Complete Works of Shakespeare, word for word, by sheer chance. The law of averages tells us that nothing can keep on happening forever. If this is true, then nothing can refrain from happening forever either!

It would be possible, obviously, to go on almost indefinitely citing examples. One might mention Mr. Tompkins who is small enough to fit through a hypodermic needle, and is injected into a human blood stream and rides through the body merrily on a red corpuscle, examining the anatomy and physiology of a human being from close-up. One might mention Alice in Wonderland, who becomes so small that she can stand on an electron and say that the nucleus looks like the sun did when she was standing on a planet. There are many fine authors who have written on scientific subjects and have included in their writing a great number of images which could have been added to this brief list. But the seven examples cited here should serve to illustrate the point I am trying to make, namely, that the teaching of any science can be greatly enhanced, made more dramatic, and more stimulating, and more complete, if the teacher, or text book author, strives, wherever possible, to use this "poetic" technique of communication, conveying with a sensory image or fantasy both the intellectual ideas involved and the analogous sense experience.

References

1. The image in example #1 comes from Fritz Kahn's, *Design of the Universe.*
2. Example #2 is taken from Linus Pauling's, *College Chemistry.*
3. Example #4 comes from Gamow's, *One Two Three Infinity.*
4. Example #7 comes from James Jeans's, *The Mysterious Universe.*

BIOLOGICAL PREREQUISITES FOR TEACHING INTRODUCTORY PSYCHOLOGY

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Phoenix Public Schools, Phoenix, Arizona

We hear many complaints that the curricula of the public schools are not adapted to the youngster's interests, and to some extent this may be true. But, it is equally true that the youngster must do a great deal of adapting to a school situation regardless of how suitable a curriculum is developed. A field which seems to be neglected, but which would help the student to adapt to this artificial learning situation called "going to school" is the field of personal understanding, acceptance of one's self, and of one's place in society.

Psychology has been taught in the public schools for many years, sometimes only incidentally to a course in social studies, in which it is hoped the student will transfer social concepts to his own behavior. This seldom happens. Sometimes it has been taught as a purely experimental science dealing with lower animals, where again it is hoped the student will transfer knowledge of the behavior of white mice to his own behavior. This, also, seldom happens. But, when the study of human behavior is directed toward the individual studying it, as it can be through a beginning psychology class, observable changes take place in that individual's behavior and the rather controversial reliance upon transfer is not necessary. Without regard for the specific learning products that result from a high-school psychology course, if an individual more adequately adjusts to his surroundings through greater understanding of himself, the course has justified itself in the curriculum.

Following the educational "discovery" of individual differences among students, certain changes were made in the curricula of the public schools in recognition of these differences. As the school population grew, hopes ran high that the counseling program in the schools would help shoulder the increasing problem of recognizing individual differences. Now, with the public-school enrollment at an all time high, perhaps, as has been suggested by many educators, the answer lies in the realm of group dynamics. This can be effectively carried out in a high school psychology course, but the beginning psychology course needs a prerequisite! This prerequisite should be a course in biology wherein the broad ideas relating to the nervous system, the senses, the learning processes, and heredity are explored and understood.

Such a background would allow the instructor to merely review

biological concepts and save valuable time especially in the semester course. It would also enable the instructor to proceed from general concepts in the field of biology to their particular implications in the field of psychology. To illustrate this dependence of an adequate understanding of psychology upon a background of biology, let us place in category B, a biological concept (or concepts) which could reasonably be expected to result from a general course in biology at the high school level. In category P, let us place a generalization (or generalizations) from the field of psychology. The dependence of P upon B should then be evident.

B

I. "Generally speaking, the higher an organism is in the scale of life, the more complex are its structures."

P

Man is not only physically but also psychologically the most complex of living organisms.

B

II. "Plants and animals respond to various kinds of stimuli in their environment."

"Division of labor in the nervous system is accomplished by special organs that are sensitive to stimuli, such as light, contact, sound."

P

Man's senses enable him to get in touch with his environment and are the receivers of stimuli which affect his behavior.

B

III. "Behaviors of living things are adaptations which enable them to survive and to continue their kinds."

"Protective adaptations are an aid to survival."

P

Adjustment mechanisms are used by everyone to a greater or lesser degree, and only become dangerous when the individual no longer distinguishes between the indirect satisfaction and reality.

B

IV. "All protoplasm has the characteristic of irritability."

P

The effect of drugs, tobacco, and alcohol on the nervous system is variable but may generally be said to produce sedation or stimulation.

B

V. "A reaction is successful if, directly or indirectly, it increases the organism's chances of survival."

P

Tension prepares the individual for flight or fight.

Anything which reduces tension is a psychological adjustment.

B

VI. "Complex behavior involves action by the nervous system, the endocrine system, and the muscular system."

P

Emotional states may be measured even though the individual's overt behavior is seemingly unchanged since certain visceral reactions take place over which the individual has no control.

B

VII. "All the bodily functions of the higher animals are controlled by the nervous system."

P

The central nervous system and the autonomic nervous system both have nerve endings in the same organs so that behavior involving these organs may be either deliberate or unconscious.

B

VIII. "Sense organs are important factors in survival."

P

Whenever a sense organ does not function properly, a compensating kind of behavior takes place.

B

IX. "The natural behavior of animals can be changed or conditioned."

"Animals with complex nervous systems may be conditioned more readily than those with simpler nervous systems."

P

Man learns by many of the same means as lower animals and in addition uses insight and language.

A human being attains a human personality only through contact with other human personalities.

B

X. "Every cell develops from another cell."

"Every embryo begins life as a fertilized egg."

"Every living thing is descended from either one or two parents."

P

Fraternal twins inherit different characteristics and may exhibit diverse personalities.

B

XI. "Some changes in living things make them better able to sur vive, while others bring about their disappearance from the earth."

P

Man's advantage over other animals, in adaptations for survival, lies in his relatively unlimited ability to learn.

B

XII. "Plant and animal characters are inherited according to defi nite laws."

"Heredity provides the native capacities of a plant or an animal, and environment determines to a great extent how fully these capacities will be developed."

P

The capacity to learn is largely an hereditary factor and is therefore independent of amount of education.

The environment influences obtained I.Q. scores, but cannot alter innate capacity.

B

XIII. "Every living thing is a product of two inseparable factors, heredity and environment."

P

Heredity and environment always interact in determining an individual's behavior.

The environment of a human being must be interpreted to include all influences from embryonic stages to the unique position of the adult in society.

B

XIV. "Acquired characters are not inherited."

P

Other than diseases or hereditary defects, mental illnesses result from inability to resolve conflicts and therefore cannot directly be inherited.

Criminal behavior is relative to the time and the society in which it occurs, and therefore is never hereditary.

It is doubtful if any such quality as "mother instinct" exists in the human animal, and love between children and parents, natural or foster, must be learned.

B

XV. "Living things become adapted to a wide range of habitats."

P

Life is a constant process of adjustment.

Of course, other circumstances such as "intent to learn" and the individual's idea of himself, will influence the student's degree of understanding of psychological generalizations. These influence the degree of understanding in any academic subject, but background in biology will result in a deeper understanding of psychology, whether the latter course is offered at the secondary level or first encountered in college.

It's faith in something and enthusiasm in something that makes life worth looking at.

—HOLMES

MATHEMATICS TEACHING ESSAY CONTEST

Kappa Mu Epsilon and the Science Teaching Improvement Program (STIP) of the American Association for the Advancement of Science (AAAS) are cooperating in the sponsorship of an essay contest on the subject, "Opportunities in Teaching Mathematics in Secondary Schools." Satisfactory essays will be published in *The Pentagon*. The prize-winning essays will also be offered for publication in *The Mathematics Student Journal*.

Purpose of the Contest

The Mathematics Teaching Essay Contest is planned to increase interest in the teaching of mathematics at the secondary-school level. It is intended to encourage undergraduate and graduate students in mathematics to consider the advantages of a career in secondary-school mathematics teaching. It is also hoped that the preparation of, as well as the reading of the essays, may interest good students with an aptitude for and interest in mathematics to enter the teaching profession. The importance of the ability to express oneself in writing, particularly on the part of teachers, should also be emphasized by such an essay contest.

First prize in the contest will be $50. There will be second and third prizes of $25 and $15, respectively.

Conditions of the Contest

1. Essays submitted in the contest should reach Professor Carl V. Fronabarger, Southwest Missouri State College, Springfield, Missouri, no later than April 1, 1957.
2. The essays must not be more than 1000 words in length, and should be typed double-spaced on a good grade of paper. Four (4) copies should be submitted by each contestant.
3. The content of the essay should be as specific as possible, and should be intended to point out the advantages of preparation for the teaching of mathematics at the secondary-school level. The essay may consider one or more of the special facets of the profession of mathematics teaching, or cover the general area as completely as the length of the essay will permit.
4. Undergraduate and graduate students in mathematics are eligible to enter the contest.
5. Essays submitted will become the property of Kappa Mu Epsilon and STIP.
6. The essays will be judged on accuracy and objectivity of the data presented, the degree to which the essay appears to be convincing in the case presented for mathematics teaching, and composition and neatness of the essay.
7. The judges of the contest will be a panel of five (5) college and secondary-school teachers of mathematics.
8. A bibliography of source material should be included.

NOMINATIONS FOR OFFICERS OF CASMT

The members of the Nominating Committee of CASMT are very anxious to submit a slate of nominees at the annual business meeting on November 24, 1956 that will represent the consensus of as many of the members as possible. You can assist them by sending to any member of the committee your suggestions for nominees. The officers to be elected are: President and Vice-president, each to serve a one-year term and four Board Members, each of whom has a three-year term.

The members of the Nominating Committee are: Edward Bos, Proviso Township High School, Maywood, Illinois; Clyde McCormick, ISNU, Normal, Illinois; Milton Pella, University of Wisconsin, Madison, Wisconsin; Iva Spangler, Central High School, Ft. Wayne, Indiana; Cecilia J. Lauby, Chairman, ISNU, Normal, Illinois.

A "NEW LOOK" AT GEOGRAPHY

JAMES K. ANTHONY
Southern University, Baton Rouge, Louisiana

Not so long ago a student from a mid-western university remarked that the deadest course that she ever had in school was one in geography and in her classification of subjects she has listed geography as *Mortuary Science 100*. Another student regarded his introductory course as an experience with Jurassic fossils. The only difference between the teacher and the course was the occasional breathing of the teacher. Such a beginning for a course in geography is sheer murder. The very subject matter itself is dynamic, not only rotationally but tectonically as well. Therefore, the methods of teaching geography should be subject to changes. Not only does a wise man change but so do modes of dress, preparations of food, and everything else that is not hidebound.

The teaching of geography has been sacrificed too long upon the altar of *staticness*. There are certain principles that should be taught in an introductory course and as the wide variety of the baker's cookies appeal to one's epicurism, so should geography be made to whet one's intellectual appetite. The course should never begin with the hard, cold facts of geodetic progress or the idiosyncrasies of isostatic balance. Certainly a less formidable approach can be found just by looking up from the printed page. The following approach is used by the author with a satisfying degree of success if student comment and performance may be regarded as valid.

On the first day of class and after the minor informalities have been completed, the course is begun with the question: what is geography? The students are allowed to voice their ideas as to what they think the correct answer is. The teacher remains non-committal until everyone has expressed himself. Then a simple dictionary definition is given—not to be remembered *in toto*—but only to direct the thinking of the students as a more collegiate definition comes later. Next the relationship of the sciences is discussed with geography as the core. The aim is to show that there are no pure and distinct sciences and as such an insight as to what geography really is begins to be discernible. Having thus indicated a philosophy of geography, the next step is to pose the provocative question of the origin of the earth. Tact must be exercised especially since religious biases may be encountered. The origin of the earth is still in the theory state (depending on whether the course is taught on Sunday or Monday) and no definite conclusion can be reached. However, the latest trend of cosmological thinking can be discussed starting first with the early beliefs of man and their developments into the theories of LaPlace,

Weizsacker, Jeans, and Chamberlin-Moulton. The main ideas of these theories are only mentioned and the summary of this unit points to the origin of the earth as being the result of a stellar catastrophe.

The next step is postulated upon *if*. If the formation of the earth is the result of a stellar accident and if the earth, as a rotating sphere of that collision, is cooling off, then what is the proof that the earth existed in a much hotter state than it is now? The answer is the ultra hot condition of the interior of the earth and its manifestations in the form of eruptions of molten rocks, hence a unit on vulcanism.* This unit treats of definitions of common terms used in vulcanology, locations of world famous volcanoes, interesting stories of their eruptions, their devastating effects upon man and the land, and finally the economic aspects of vulcanism.

Mountain-building, the effects of glaciation on land, formation of deserts, island types, and coastline irregularities constitute the unit on geomorphology. And to make it a geographical study, man and his way of living in the above regions is stressed. The subsistence agricultural activities of man in mountainous areas is contrasted with the restricted (in some cases) nomadic existence of desert dwellers and of the plenteous products of the plainsmen. The continental ice sheets that covered New England have left a cool, loamy soil that makes Maine a leader in the potato industry. The podzolic soil gives rise to extensive forests that provided the economic background for Ben Ames Williams' *The Strange Woman*. The Six Great Lakes, having been gouged out by the Wisconsin Ice Sheet, provide that all-important inland waterway of the American steel industry as well as allied economical ventures. The former Lake Agassiz is now the location of our great northern wheat region. Hungary, likewise once under a glacial lake, is now a great wheat-growing region in Europe, so much so that it is frequently referred to as *the breadbasket of Europe*.

In the unit on soils the relationship of man to the soil is emphasized. Man came from the soil, his existence and sustenance is from the soil and he is intimately linked with it. It is here that a more advanced definition of geography is given, e.g., *geography is a relationship between the physical and biological factors of a region and how man combines these factors to make the region an economic entity*. After a study of soil characteristics, an attempt is made to show how man's economic activities are linked with the particular type of soils of his region. If he is a son of the desert then the soil productivity will range from medium to high assuming there is irrigation, e.g., the

* Anthony, James K., "Regions of Vulcanism," SCHOOL SCIENCE AND MATHEMATICS, May 1953, pp. 387–397.

Imperial Valley. If there is no irrigation then life will be futile, e.g., the Danakil and Namib Deserts. With good care, chernozem soil makes man quite successful with his cash grain farming of wheat, corn, flax, oats, soybeans, and wild hay. Podzolic soils contribute to a wide variety of crops if the management of the soil has been intelligent. The range is from general farming of cereal grains and truck crops, to forestry.

Next comes the vital statistics of the earth. This is a purely factual unit on the diameter of the earth; its distance from the sun; its period of rotation and revolution; the inclination of the earth's axis which results in the seasons of the year; and the study of latitude and longitude.

The movie, *A Global Concept in Maps* introduces the unit on maps. Attention is called to the map families and the uses of some of the more popular projections. The newly-developed raised surface maps that show through the use of contour lines as well as by elevation the terrain of the land may be used to good advantage at this point.

The course is concluded with a study of weather and climate. It is the human element that makes geography alive and problems on man's existence in the several climatic regions should not be overlooked in this unit, either. Certainly the Jacques May studies in medical geography should be mentioned and their correlation with climatic factors. One need not be a biologist to appreciate his findings. The unit might be ended with a discussion of Huntington's provocative *Mainsprings of Civilization* or Kimble's whimsical *Our American Weather*.

FREE COLOR FILMSTRIP

"Your Trip Through the Suez Canal," 65 frames and maps; 8-page booklet distributed, one to a teacher, upon request to *Vacuumate Corporation, 446 West 43rd Street, New York 36, N. Y.* The filmstrip describes a journey through the world's largest canal and explains its operation and its growing importance to world commerce and U. S. economy.

REPRINTS

"The Suez Story," an eight-page teaching unit originally published by Scholastic Magazines. The unit is illustrated and includes a lesson plan. It is available free in classroom quantities upon request to:

Suite 515
Teachers Library
1590 Broadway
New York 19, New York

No fountain is so small but heaven may be imaged in its bosom.
—HAWTHORNE

SOLUTIONS FOR ABSOLUTE INEQUALITIES*

DAVID H. WORDELL
1005 Maple Street, Fall River, Mass.

Let $P_n(x) \equiv x^n + a_1x^{n-1} + \cdots a_n$ be a polynomial factorable into linear factors $(x-r_1)\ (x-r_2) \cdots (x-r_n)$ where r_i is real, arranging factors so that $r_1 \geqq r_2 \geqq r_3 \geqq \cdots r_n$.

$$P_n(x) > 0$$

Case 1. r's are distinct
(a) if n is odd

Solution. $x > r_1 \qquad r_2 > x > r_3 \qquad r_4 > x > r_5 \cdots r_{n-1} > x > r_n$

(b) if n is even

Solution. $x > r_1 \qquad r_2 > x > r_3 \qquad r_4 > x > r_5 \cdots r_{n-2} > x > r_{n-1} x < r_n$

Case 2. r's are not all distinct—cast out all $(x-r_i)^{2m}$ where r_i appears either 2^m or 2^{m+1} times and continue as in Case 1.

Proof: Each solution gives an even number of negative factors thus making the product + as required.

$$P_n(x) < 0$$

Case 1. r's are distinct
(a) if n is odd

Solution. $r_1 > x > r_2 \qquad r_3 > x > r_4 \cdots r_{n-2} > x > r_{n-1} \qquad x < r_n$

(b) if n is even

Solution. $r_1 > x > r_2 \qquad r_3 > x > r_4 \cdots r_{n-1} > x > r_n$

Case 2. r's are not all distinct—proceed as in Case 2 above.

Proof: Each solution gives an odd number of negative factors thus making the product − as required.

* Last year, as a freshman studying inequalities at Bradford Durfee Technical Institute, Fall River, Massachusetts, I discovered a fast, simple method for solving certain inequalities. In some cases the answer can be derived simply by inspection. This method has been used very successfully by several members of my class.

Compound Microscope features interchangeable and reversible inclined monocular, binocular and trinocular bodies. Stage and specimen are focusable to the objective by low-positioned coarse and fine adjustments, while body tube height and eye level remain constant. A built-in illuminator and 35 mm. camera attachment are available.—American Optical, Instrument Div., Box A, Buffalo 15, N. Y.

Always laugh when you can; it is cheap medicine.

—FRANKLIN

A FANTASY OF 1956

EDWARD C. COLIN
900 East 83rd Street, Chicago 19, Illinois

You of course have heard of "flying disks" or "flying saucers." In recent years the newspapers and magazines in this country have flooded us with reports of strange flying objects, seen by reputable aviators and others, traveling through the air at terrific speeds. Like you, I thought that these accounts were mere hallucinations, products of war neuroses, until a few months ago. Then one day while following a little-used trail high up in the Rocky Mountains of Colorado I decided to do a bit of exploring of my own on the way back to camp. Striking out across an extremely rugged canyon, after half an hour's climbing I was pulling myself up on the opposite side when, suddenly, I noticed a sheet of metal about the size of an ordinary letterhead, wedged securely in the crack of a rock.

It was dull green in color and bore on both sides many rows of extremely fine markings. I had never seen nor heard of anything like it before. Having in my pocket only a weak magnifying glass, I could make nothing out of the markings. Accordingly, I dropped the sheet in my knapsack and carried it back to camp. There, under the microscope with reflected light at low magnification, the markings showed up clearly as rows of beautiful and delicately etched characters. The number of types of distinctive characters was limited, and these fell into a variety of patterns much as do the letters in our printed words.

To end the story at once, after many weeks of intensive study, I have finally succeeded in deciphering the inscriptions. The sheet turns out to be a news sheet published by the inhabitants of the planet Nemo of the Star Arcturus in the Constellation Boötes. As you are aware, Arcturus is one of our near neighbors, only about thirty-three light years away. Heretofore we have had no knowledge of the existence of its planet Nemo.

The sheet is dated July 28, 1914, on the very day of departure of a space ship bound for the Solar System to discover whether our planet, the existence of which has long been common knowledge to the Nemos, might be suitable for colonization by them after their own planet becomes unsuitable for life. This development is estimated by them to be due in only a few million years.

Another problem, which from the news sheet I learn is occupying the minds of their leaders, is whether *Homo sapiens* would make a desirable domesticated animal for them in case they should decide to occupy the Earth—or whether he should be painlessly exterminated. On this latter question there has been no little discussion

among their statesmen, scientists, and philosophers. One school of thought, which at the moment appears to be dominant, holds that since the Nemos and Man have no genetic relationship, each species having evolved entirely independently of the other, and since the Nemos and their culture are far superior to Man in almost every respect, including intellect especially, that they have no moral obligation whatsoever to consider Man's interests. They point out that Man himself would have to admit the justice of this position, because men, with very few exceptions, have never hesitated to do with the other million species of animals on earth whatever they wished. The Nemos admit, of course, that the more civilized of men have conscientious scruples against unnecessarily causing suffering to other species. But this, they declare, is irrelevant. The Nemos many centuries ago banned all cruelty to their own lower species. They have had no wars among themselves for over a million years. The advocates of the extermination policy emphasize the fact that there would be no cruelty involved in exterminating Man: for the Nemos have the knowledge required to accomplish his extinction instantaneously and painlessly and with no advance warning. Consequently, no mental suffering would be involved.

Another school of thinkers among the Nemos, however, which now is in a very small minority, holds that it would be wrong to exterminate Man, because, admitting that his present status is very primitive, he is a young species and shows possibilities of becoming something excellent indeed in the two billions or more years that are available to him on earth. He exists in large numbers, with a rate of reproduction that is more than ample. He has great variability and a high mutation rate, which will provide the raw material for future progressive evolution. With his present start in intelligence and his plastic nervous system he might, it is thought, even surpass the level possible for the Nemos.

The advocates of this idealistic point of view argue that there may be a higher morality than the promotion of the welfare of one's own species; that the principle of self-sacrifice of the individual for the good of the species should be applied also between species, even between those inhabiting different planets of different stars; that a species reaches its noblest destiny when it acts for the promotion of evolutionary progress wherever evolution may be operating in the Universe. On the basis of their own experience they have little doubt that long before the Earth becomes unsuitable for Man he will have developed means for discovering and occupying some other planet—provided, of course, that he learns in time to control his predatory instincts and turns his energies to the conscious and voluntary evolution of his own species and to the conquest of space.

This conflict of points of view indicates that the minds of the Nemos operate very much like our own and that like ourselves they have their absolutists as well as their relativists. Several pictures in the Nemos' news sheet show clearly that in physical traits they are very different from ourselves, although, as we have seen, in mentality they are very similar to us. The discovery of the Nemos' visit to the Earth has raised several questions in my mind, as I hope it has in yours. One of these which it seems to me might well be worth investigating is this: are there different kinds of mentality, or is it probable that mentality is essentially the same wherever it is found in the Universe?

ENGINEERING COLLEGES ARE IN REAL TROUBLE FOR TEACHING STAFF

The engineering colleges of the United States have experienced a net loss of three per cent of their professors to industry within a two-year period—and this at a time when the engineering colleges need 1300 more teachers to carry the 1956–57 load.

This serious situation was reported to the American Society for Engineering Education by an industry committee headed by A. R. Hellwarth, Assistant to Director of Employment, The Detroit Edison Company.

The committee, acting under the Relations with Industry Division of the ASEE, reported that during the two-year period more than 750 left engineering faculties for industry with higher salaries being the major lure. Fortunately for education, 500 left industry for teaching positions. The 150 colleges and universities accredited by the Engineers' Council for Professional Development covered by the industry committee's survey reported a gain in teaching strength from 8000 to 8400 during the period in spite of losses to industrial employers. The 1300 present shortage would require the engagement of 15 additional professors or instructors for every 100 now teaching.

NEW DEAN OF MMCC

Dr. Margaret Foster LeClair is the new dean of Margaret Morrison Carnegie College, Carnegie Tech President Dr. J. C. Warner announced. She replaces retiring dean Edith Winchester Alexander who has been head of the college since 1947.

Beginning July 1, Dr. LeClair will have the responsibilities of administering the education of over 500 women students in the college's four departments: general studies, home economics, biological sciences, and secretarial studies.

Dr. LeClair has been head of the department of general studies and associate professor in English. She will retain her academic appointment in addition to her new duties.

The new dean joined the Carnegie faculty in 1946 from New York State College for Teachers at Buffalo and has also been on the faculty of Ohio State University where she received her master's degree and her doctorate. She holds a bachelor's degree from Ohio Wesleyan where in 1932 she won the Dustin Prize in short story and essay writing, and in 1933 was awarded the Wheeler Prize in poetry, the Davies Prize in German and the Slocum Prize in scholarshlp.

At Carnegie Tech, Dr. LeClair has served on the academic program committee for the College of Fine Arts and on the advisory committee for the Division of Humanistic and Social Studies. She is present chairman of the H&SS faculty.

Dr. LeClair is married to Charles LeClair, Head of Fine Arts at Chatham College in Pittsburgh.

WHAT CAUSES THE TRADE WINDS AND THE WESTERLIES?

REBECCA E. ANDREWS
Woodrow Wilson High School, Washington, D.C.

Many physics textbooks show a diagram of the earth with the directions of the trade winds and of the westerlies indicated by arrows on the surface of the earth. See Figure 1. But pupils in high school do not understand why winds are affected by the rotation of the earth the way they are.

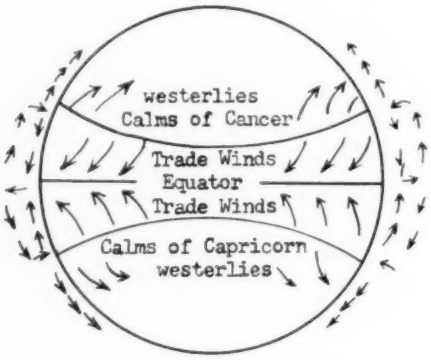

FIG. 1

The understanding of the following explanation appears to lie within their degree of readiness. The explanation may by analyzed into three parts: Lesson A, Lesson B, and Lesson C.

Lesson A. As an automobile moves, it carries with it a drift of air. If it move from west to east and there is no wind blowing, the auto

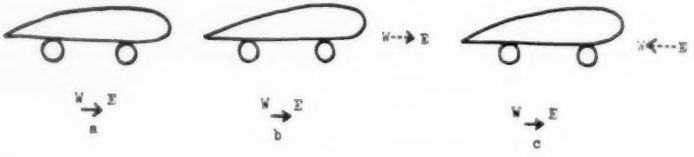

FIG. 2

carries with it a drift of air from west to east. See Figure 2a. Now suppose that, as the car moves from west to east, the occupant notices a faster stream of air outside. The occupant would interpret this as a wind from west to east. See Figure 2b. Now suppose that, as the car continues from west to east, the occupant notices a slower stream of

air outside. The occupant would interpret this as a wind from east to west. See Figure 2c. And this is Lesson A.

Lesson B. A person with two heavy balls stands on a turntable and the turntable is rotated. When the balls are moved far from the body, he rotates more slowly (Figure 3a). When the balls are moved near his body, he rotates more rapidly (Figure 3b). This is in accordance with the law of conservation of angular momentum. Perhaps the high school teacher will be forgiven if he state at this time only the special case of the law that, as the radius increases, the angular speed decreases and, as the radius decreases, the angular speed increases. And this is Lesson B.

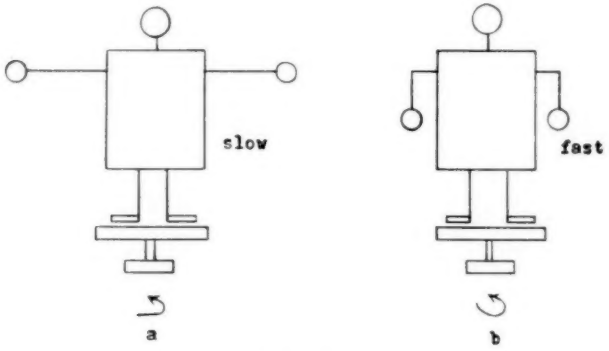

FIG. 3.

Lesson C. Both Lesson A and Lesson B may now be applied to the directions of the trade winds and of the westerlies. In the northern hemisphere directly north of the equator the convection current is toward the south. As is usually known, the warm air at the equator is less dense than the cold air north of the equator and this difference in densities gives rise to an unbalanced pressure from the more dense air at the north to the less dense air at the equator. So the cold air of the north pushes southwards upon the warm air of the equator. And, since the distance around the earth is greatest at the equator, the air moves from a location of smaller radius to one of larger radius. The air must move more slowly (Figures 3a and 3b). If it moves more slowly, it must appear to come from the east (Figure 2c). The direction of the trade winds in the southern hemisphere follows the same logic.

If it be assumed that the direction of some of the air at the Calms of Capricorn is northwards, then the explanation of the direction of this air which gives rise to the westerlies is similar. At the Calms of Cancer the air near the earth is moving northward. The air moves

from a larger radius to a smaller one. Therefore it speeds up (Figures 3a and 3b). If it speeds up, it appears to come from the west (Figure 2b). A similar situation obtains for the air at the Calms of Capricorn. These winds, therefore, appear to come from the west and are called westerlies.

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve her readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems and solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2499. *J. Byers King, Denton, Md.*

Correction: Problem **2520,** April issue. The last term in the expression should have read $-4abc$ instead of $-4c$ as printed.

2509. *Proposed by Julius Sumner Miller, El Camino College.*

From a height h a "loop-the-loop" car comes down its track and runs around the inside of a vertical circular loop of radius R feet. From what height must it start so as not to leave the loop?

Solution by C. W. Trigg, Los Angeles City College

If the car just touches the top of the loop, the centripetal force at that point is provided by gravitational attraction, so

$$g = v^2/R \tag{1}$$

Equating loss of potential energy to gain in Kinetic energy, we have

$$mg(h-2R) = \tfrac{1}{2}mv^2 \tag{2}$$

Hence from (1) and (2),

$$h = 2R + \frac{v^2}{2g} = 2R + \tfrac{1}{2}R = 5R/2.$$

Thus, for the car to stay in the loop it must start from a height greater than $5R/2$ above the bottom of the loop, to compensate for energy loss due to friction.

A solution was also offered by the proposer.

2510. *Proposed by Brother Felix John, Philadelphia, Pa.*

Show that

$$3^{2n+3} + 160n^2 - 56n - 243$$

is divisible by 512.

Solution by the Proposer

Let

$$f(n) = 3^{2n+3} + 160n^2 - 56n - 243$$

Then

$$\begin{aligned} f(n+1) &= 3^{2n+7} + 160n^2 + 264n - 139 \\ f(n+1) - 9f(n) &= -8(160n^2) + 768n + 2048 \\ &= 12(4 + n - 2n^2) - 256n(n-1) \\ &= 512K_1 - 512K_2, \text{ since } n(n-1) \text{ is even} \\ &= 512k \end{aligned}$$

Solutions were also offered by William V. Gamzon, Long Beach, Calif.; Benjamin Greenberg, New York, N.Y.; Paul H. Renton, Westbrook, Conn.; W. R. Talbot, Jefferson City, Mo.; and C. W. Trigg, Los Angeles, Calif.

2511. *Proposed by Christos B. Glavas, New York, N.Y.*

Take a circle of radius r and suppose that the circle rolls on a line from an initial point O. Find the locus of the point P which is the foot of the perpendicular from O upon the tangent at the point M on the rolling circle. This curve might be christened "Tangential Cycloid."

Solution by C. W. Trigg, Los Angeles City College

Let the origin, O, be the initial position of M. Then, when the circle has rolled through an angle θ along OX, we have

$$M(r[\theta - \sin\theta],\ r[1 - \cos\theta])$$

and the slope of the radius to M is

$$\tan\left(\frac{\pi}{2} - \theta\right)$$

or $\cot\theta$. The equations of the lines are

PM: $$y - r[1 - \cos\theta] = -\tan\theta[x - r(\theta - \sin\theta)]$$

OP: $$y = x\cot\theta$$

Eliminating y,

$$\begin{aligned} -r[1 - \cos\theta] &= -[\tan\theta + \cot\theta]x + r\tan\theta[\theta - \sin\theta] \\ x &= \frac{r[1 - \cos\theta + \tan\theta(\theta - \sin\theta)]}{\tan\theta + \cot\theta} \\ &= \frac{r[\cos\theta - \cos^2\theta + \theta\sin\theta - \sin^2\theta]}{\cos\theta[\tan^2\theta + 1]\cos\theta/\sin\theta} \end{aligned}$$

Therefore the parametric equations of the locus of P are

$$x=r(\cos\theta+\theta\sin\theta-1)\sin\theta,\ y=r(\cos\theta+\theta\sin\theta-1)\cos\theta.$$

A solution was also offered by W. R. Talbot, Jefferson City, Mo.

2512. *Proposed by Brother Felix John, Philadelphia, Pa.*

If

$$\log(x+z)+\log(x-2y+z)=2\log(x-z),$$

show that x, y, and z are in harmonic progression.

Solution by Charles H. Butler, Kalamazoo, Mich.

From the given conditions it follows that

$$(x+z)(x-2y+z)=(x-z)^2$$

Expanding, collecting terms, and simplifying, we get

$$xy-2xz+yz=0 \quad \text{or} \quad xy-xz=xz-yz$$

Dividing through by xyz we get

$$\frac{1}{z}-\frac{1}{y}=\frac{1}{y}-\frac{1}{x}$$

Thus x, y, and z are in harmonic progression.

Solutions were also submitted by William V. Gamzon, Long Beach, Calif.; Benzamin Greenberg, New York, N. Y.; Margaret L. Hayes, Greenfield Center, N. Y.; J. Byers King, Denton, Md.; Amy Lowe, Adrian, Mich.; A. MacNeish, Chicago, Ill.; David Rappaport, Chicago, Ill.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; Walter R. Warne, St. Petersburg, Fla.; Alan Wayne, Baldwin, N.Y.; and the proposer.

2513. No solution has been offered.

2514. *Proposed by Paul D. Thomas, Norman, Okla.*

Construct a triangle given r_b, r_c, m_a where $r_b r_c$ are exradii relative to the sides b, c and m_a is the median upon the side a.

Solution by the Proposer

Let A' be the midpoint of side a, and O the circumcenter. K' is the point opposite A' with respect to 0 where $A'O$ meets the circumcircle. Then

$$A'K'=1/2(r_b+r_c)^*.$$

Also

$$h_a=2r_br_c/(r_b+r_c),\dagger$$

h_a is the altitude upon a. Hence the problem reduces to construct a triangle given h_a, m_a, $A'K'$.

Construction: Construct a right triangle $AH'A'$, $AH'=h_a$, $AA'=m_a$, and with vertex of the right angle at H'. On a perpendicular to $H'A'$ through A', lay off the distance $A'K'$, K' on the same side of $H'A'$ as A. Since AK' is a chord of the circumcircle, the perpendicular bisector of AK' meets $A'K'$ in the circumcenter O. The circumcircle with radius $OA=OK'$ meets $H'A'$ produced in the points B and C. ABC is the required triangle.

Solutions were also offered by W. R. Talbot, Jefferson City, Mo.; and C. W. Trigg, Los Angeles, Calif.

* See *College Geometry*, N. A. Court, pp. 73.

† See *College Geometry*, N. A. Court, pp. 74.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2512. *Hillie Cohen, David Greenserd, Karl Josephy, and Harold Keiser, Ramaz High School, New York, N.Y.*

PROBLEMS FOR SOLUTION

2533. *Proposed by Julius Sumner Miller, El Camino, Calif.*

A ball is dropped from a tower at the same instant another of equal mass is projected upward from the bottom of the tower with a velocity just enough to raise it to the top of the tower. Show that if the balls collide centrally the falling ball will rise, on the rebound, to a height $h/4(3+e^2)$ above the ground, where h is the height of the tower and e is the coefficient of restitution.

2534. *Proposed by C. N. Mills, Sioux Falls, S.D.*

Given the three points (0, 0) (0, 4) and (3, 0). Using Ptolemy's Theorem show that the equation of the circumcircle is $x^2+y^2-3x-4y=0$.

2535. *Proposed by Julian H. Braun, San Diego, Calif.*

Suppose P is the probability that at least one door of a four door automobile has a defective lock. Show that the probability of exactly two doors having defective locks is given by $3/8P^2(1+1/4P+\cdots)$.

What is the probability that exactly one door will have a defective lock?

2536. *Proposed by N. Kailasamaiyer, Madras, India.*

Given Triangle ABC. Equilateral triangles are described on the sides externally. If x, y and z are the orthocentres of the equilateral triangles, show that xyz is an equilateral triangle.

2537. *Proposed by A. R. Haynes, Tacoma, Wash.*

In triangle ABC, show

$$\operatorname{Cot} A+\operatorname{Cot} B+\operatorname{Cot} C=\tfrac{1}{2}\left[\frac{\sin A}{\sin B \sin C}+\frac{\sin B}{\sin C \sin A}+\frac{\sin C}{\sin A \sin B}\right].$$

2538. *Proposed by Brother Felix John, Philadelphia, Pa.*

Find the condition, among its coefficients, that the expression $ax^4+4bx^3y+6cx^2y^2+4dxy^3+ey^4$ should be reducible to the sum of the fourth powers of two linear expressions in x and y.

BOOKS AND PAMPHLETS RECEIVED

COLLEGE ALGEBRA, Revised Edition, by Edward A. Cameron, and Edward T. Browne, *The University of North Carolina*. Cloth. Pages x+390. 15.5×23.5 cm. 1956. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.25.

PLANT PHYSIOLOGY, Fourth Edition, Revised, by Meirion Thomas, M. A., F.R.S., F.R.S.E., *Professor of Botany at King's College, Newcastle upon Tyne, in the University of Durham*. Cloth. Pages xii+692. 13×21.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $12.00.

PRACTICAL TRIGONOMETRY, by Ralph S. Underwood, and Horace E. Woodward, *Texas Technological College*. Cloth. Pages ix+251. 14×21.5 cm. 1956. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.25.

MATHEMATICS OF FINANCE, by Robert Cissell, *Assistant Professor of Mathematics, Xavier University, Cincinnati, Ohio*, and Helen Cissell. Cloth. Pages ix+198+88. 15.5×23.5 cm. 1956. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $4.50.

MODERN BIOLOGY, by James H. Otto, *Head of the Science Department, George Washington High School, Indianapolis, Indiana;* Truman J. Moon was *Head of the Science Department High School, Middletown, New York;* and Paul B. Mann was *Head of the Biology Department in Evander Childs High School, New York City*. Cloth. Pages x+757. 15.5×23.5 cm. 1956. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.88.

MODERN PHYSICS, by H. Clark Metcalfe, *Science Department, Shaler High School, Glenshaw, Pennsylvania;* William O. Brooks was a *Teacher in the Science Department in Technical High School, Springfield, Massachusetts;* and Charles E. Dull was *Head of the Science Department in West Side High School, Newark, New Jersey*. Cloth. Pages viii+712. 15.5×23.5 cm. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.56.

MODERN HEALTH, by James H. Otto, *Head of the Science Department, George Washington High School, Indianapolis, Indiana*. Cloyd J. Julian, *Consultant in Health, Safety, Physical Education and Athletics for the Public Schools, Indianapolis, Indiana;* and J. Edward Tether, M. D., *Assistant Professor of Neurology, Indiana University School of Medicine, Indianapolis, Indiaan*. Cloth. Pages ix+566. 15.5×22.5 cm. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.12.

BEING AND NOTHINGNESS, AN ESSAY ON PHENOMENOLOGICAL ONTOLOGY, by Jean-Paul Sartre. Translated by Hazel E. Barnes, *University of Colorado*. Cloth. Pages lxix+638. 14.5×22.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

A SHORT TABLE OF INTEGRALS, Fourth Edition, by B. O. Peirce, *Late Hollis Professor of Mathematics and Natural Philosophy in Harvard University*. Revised by Ronald M. Foster, *Professor of Mathematics, Polytechnic Institute of Brooklyn*. Cloth. Pages vii+189. 13.5×20.5 cm. 1956. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.25.

ALGEBRA IN EASY STEPS, Third Edition, by Edwin I. Stein, *Leeds Junior High School, Philadelphia, Pennsylvania*. Cloth. Pages vi+298. 19.5×26 cm. 1956. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N.J. Price $2.32.

PLANE GEOMETRY, by Rolland R. Smith, *Co-ordinator of Mathematics, Public Schools, Springfield, Massachusetts;* and James F. Ulrich, *Mathematics Department, Township High School, Arlington Heights, Illinois*. Cloth. Pages viii+536. 15×23 cm. World Book Company, Yonkers-on-Hudson, N. Y. Price $3.84.

GOING PLACES WITH MATHEMATICS, by M. Peters, *Chairman, Department of Mathematics, George W. Wingate High School, New York*. Cloth. Pages viii+362. 15×23 cm. 1956. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $3.22.

A DICTIONARY OF DIETETICS, by Rhoda Ellis, Ph.D., *Instructor of Foods and Nutrition, Department of Home Economics, Brooklyn College, New York*. Cloth. 152 pages. 14×20.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

WORLD AIRCRAFT RECOGNITION MANUAL, by C. H. Gibbs-Smith and L. E. Bradford. Cloth. Pages xv+269. 13×20 cm. 1956. John de Graff, Inc., 31 East 10th Street, New York 3, N.Y. Price $3.50.

FUNCTIONAL MATHEMATICS, Book 4, by William A. Gager, Luther J. Bowman, Carl N. Shuster, Franklin W. Kokomoor. Cloth. Pages xiv+578. 15.5×23 cm. 1956. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $3.40.

THE DESCENT OF PIERRE SAINT-MARTIN, by Norbert Casteret. Cloth. Pages xi+160. 13.5×21.5 cm. 1956. The Philosophical Library, Inc., 15 East 40th Street, New York 16. N. Y. Price $4.75.

MATHEMATICAL ANALYSIS, A MODERN APPROACH, by Walter T. Hamilton, *Assistant Professor of Mathematics, Long Island University,* and John Raymond Hamilton, *Assistant Professor of Mathematics, Long Island University.* Cloth. Pages xiii+379. 15.5×23.5 cm. 1956. Harper and Brothers, 49 East 33d Street, New York 16, N. Y. Price $4.50.

ELEMENTS OF MATHEMATICS, by J. Houston Banks, *George Peabody College for Teachers.* Cloth. Pages x+422. 14.5×23 cm. 1956. Allyn and Bacon, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.75.

NEW CONCEPTS IN FLOWERING-PLANT TAXONOMY, by J. Heslop-Harrison, M.Sc., Ph.D., F.R. S.E., F.L.S., *Professor of Botany, The Queen's University of Belfast.* Cloth. Pages viii+135. 12×18.5 cm. Harvard University Press, Cambridge, Mass. Price $1.25.

DIAGNOSTIC AND REMEDIAL TEACHING, by Glenn Myers Blair, Ph.D., *Professor of Educational Psychology, University of Illinois.* Cloth. Pages xvi+409. 13.5×21 cm. 1956. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.00.

INTERMEDIATE ANALYSIS, by John M. H. Olmsted, *Professor of Mathematics, University of Minnesota.* Cloth. Pages xii+305. 15.5×23.5 cm. 1956. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $6.00.

PLANE TRIGONOMETRY, Second Edition, by E. Richard Heineman, *Professor of Mathematics, Texas Technological College.* Cloth. Pages xii+167. 15×23 cm. 1956. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $3.75.

RISK AND GAMBLING, by John Cohen, *Professor of Psychology, University of Manchester,* and Mark Hansel, *Lecturer in Psychology, University of Manchester.* Cloth. Pages x+153. 12.5×18.5 cm. 1956. Philosophical Library, Inc. 15 East 40th Street, New York 16, N. Y. Price $3.50.

ENGINEERING PROBLEMS, by Charles Angevine Hutchinson, Leon Watson Rutland, Jr., and Walter Wayne Varner, *Department of Applied Mathematics in the College of Engineering, University of Colorado.* Cloth. Pages vii+181. 17.5×25 cm. 1956. Harper Brothers, 49 East 33d Street, New York 16, N. Y. Price $3.00.

THE SCIENCE MASTER'S BOOK, SERIES III, PART IV. EXPERIMENTS FOR MODERN SCHOOLS, Edited by L. J. Rowse, M. A., *Headmaster of Goole Modern School, Yorkshire.* Cloth. Pages xiv+342. 13.5×21.5 cm. 1956. John Murry, Albemarle Street, W., London, England. Price 15s. net.

A TREATISE ON SURVEYING. VOLUME ONE; INSTRUMENTS AND BASIC TECHNIQUES, by Reginald E. Middleton, and Osbert Chadwick. Sixth Edition. Revised by B. G. Manton, *Chadwick Scholar and Medallist, University College, London.* Cloth. Pages xiii+381. 14×22.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16. N. Y.

A TREATISE ON SURVEYING. VOLUME TWO: MORE ADVANCED TECHNIQUES AND DEVELOPMENTS, by Reginald E. Middleton, and Chadwick. Sixth Edition. Rewritten under the Editorship of W. Fisher Cassie, *Professor of Civil Engineering, University of Durham.* Cloth. Pages xi+438. 14×22.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $20.00 for Volume One and Volume Two.

THE LITTLE GIANT OF SCHENECTADY. A STORY OF CHARLES STEINMETZ, by Dorothy Markey. Cloth. 191 pages. 13×20.5 cm. 1956. Aladdin Books, New York. Price $1.75.

ARITHMETIC AT WORK, Book 1, by Howard F. Fehr, *Professor of Mathematics, Head, Department of Teaching of Mathematics, Teachers College, Columbia University*, and Veryl Schult, *Supervisor of Mathematics, Public Schools of the District of Columbia.* Cloth. Pages v+410. 15×23.5 cm. 1955. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $2.80.

ARITHMETIC IN LIFE, Book 2, by Howard F. Fehr, *Professor of Mathematics, Head, Department of Teaching of Mathematics, Teachers College, Columbia University*, and Veryl Schult, *Supervising Director, Department of Mathematics*, Public Schools, Washington, D. C. Cloth. Pages v+442. 15×23.5 cm. 1956. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $3.00.

ATOMS AND ENERGY, by Professor H. S. W. Massey, F.R.S. Cloth. 174 pages. 13.5×21.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y.

HYDRODYNAMICS, by Hugh L. Dryden, Francis D. Murnaghan, and H. Bateman. Paper. 634 pages. 12.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $2.50.

THE PRINCIPLES OF MECHANICS PRESENTED IN A NEW FORM, by Heinrich Hertz. Paper. Pages 44+274. 12.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.75.

INVESTIGATIONS ON THE THEORY OF THE BROWNIAN MOVEMENT, by Albert Einstein, Ph.D. Paper. 122. pages. 12.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.25.

TRIGONOMETRICAL SERIES, by Antoni Zygmund, Second Edition. Paper. Pages vi+329. 15×23 cm. 1952. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $1.50.

IRRATIONALZAHLEN, by O. Perron, Second Edition. Paper. Pages viii+199. 13.5×20.5 cm. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $1.50.

ELECTRIC CIRCUIT THEORY AND THE OPERATIONAL CALCULUS, Second Edition, by John R. Carson, *American Telephone and Telegraph Company.* Paper. Pages ix+197. 13.5×20.5 cm. 1926. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $1.88.

INTRODUCTION TO THE THEORY OF GROUPS OF FINITE ORDER, by Robert D. Carmichael. Paper. Pages xiv+447. 12.5×20.5 cm. 1937. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $2.00.

FAMOUS PROBLEMS OF ELEMENTARY GEOMETRY, by Felix Klein. Paper. Pages xi+92. 12.5×20.5 cm. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.00.

HOW TO CALCULATE QUICKLY, by Henry Sticker. Paper. Pages x+256. 12×18.5 cm. 1955. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.00.

EUCLIDS ELEMENTS, by Thomas L. Heath, *Honorary Fellow (Sometime Fellow) of Trinity College, Cambridge*. Second Edition, Revised with Additions. Volume I, Books I, and II. Paper. Pages xi+432. 12×20 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price 1.95.

EUCLIDS ELEMENTS, by Thomas L. Heath, *Honorary Fellow (Sometime Fellow) of Trinity College, Cambridge*. Second Edition, Revised with Additions. Volume II, Books III and IX. Paper. 436 pages. 12×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.95.

EUCLIDS ELEMENTS, by Sir Thomas L. Heath, *Honorary Fellow (Sometime Fellow) of Trinity College, Cambridge*. Second Edition, Revised with Additions. Volume III, Books X and XIII. Paper. 546 pages. 12×20 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.95.

BLOCKING OSCILLATORS, edited by Alexander Schure, Ph.D., Ed. D. Paper. Pages vii+64. 14×21.5 cm. 1956. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $1.25.

AMPLITUDE MODULATION, edited by Alexander Schure, Ph.D., Ed. D. Paper. Pages vii+56. 14×21.5 cm. 1956. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $1.25.

EXPERIMENT AND THEORY IN PHYSICS, by Max Born, M.A., Ph.D., Sc.D.h.c., F.R.S., *Tait Professor of Natural Philosophy, University of Edinburgh*. Paper. 56 pages. 13×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price 60 cents.

ASYMPTOTIC EXPANSIONS, by Professor A. Erdélyi, *California Institute of Technology*. Paper. Pages vi+122. 13.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.35.

AN ESSAY ON THE FOUNDATIONS OF GEOMETRY, by Bertrand A. W. Russell. Paper. 121 pages. 13.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.50.

INFINITE SEQUENCES AND SERIES, by Dr. Konrad Knopp. *Emeritus Professor of Mathematics at the University of Tübingen*. Paper. 191 pages. 13.5×20.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.75.

THE ELECTRONIC BRAIN AND WHAT IT CAN DO, by Saul Gorn, *Associate Professor at the Moore School of Electrical Engineering University of Pennsylvania*, and Wallace Manheimer, *Mathematics Department, Franklin K. Lane High School, Brooklyn, New York*. Paper. 64 pages. 13.5×21.5 cm. 1956. Science Research Associates, 57 West Grand Avenue, Chicago 10, Ill.

ARITHMETOONS, by Lowry W. Harding. Paper. 91 pages. 13.5×21.5 cm. 1956. Wm. C. Brown Company, Dubuque, Iowa. Price $.1.50.

Electric Hand Lamp for use in hazardous locations is a big beam, explosion-proof light. It has a sparkproof case and a spring bulb ejector. The container and head are of drawn brass finished in red enamel; the handle of die cast zinc, and wires are sheathed in brass tubing. It operates on two standard six-volt batteries. —U-C Lite Mfg. Co., 1050 W. Hubbard St., Chicago 22, Ill.

The safest principle through life instead of reforming others is to set about perfecting yourself.

—HAYDEN

BOOKS REVIEWS

THE WHY OF CHEMISTRY PROBLEMS, by Fred B. Eiseman, Jr., *Chairman, Science Department, John Burroughs School, St. Louis, Missouri.* Cloth. 21.5×13.5 cm., pages 1–303. 1954. Educational Publishers, Inc., St. Louis 1, Missouri.

Teachers of Chemistry are often accused of making the beginning course too mathematical. It is true that they give students problems which are based on the principles studied and they feel that the student's ability to solve the problems is a measure of their understanding of the principle involved.

For the beginning chemistry student who is having difficulty with chemical arithmetic, this book should be helpful. The author's aim, as given, is to solve problems by reasoning rather than blind memorization of formulas.

The first chapter treats the technique of solving problems and includes problem analysis, thinking through the problem and finally checking the result. The ideas of direct and inverse variation are clearly explained and illustrated. This chapter is followed by a treatment of the units of metric system and their English equivalents. Chapter 3 gives emphasis to the importance of significant figures, while Chapter 4 deals with matter energy relations and Einstein's relativity equation, namely, $E=mc^2$.

Chapters 5–11 inclusively treats the subjects of atomic and molecular weights, derivation of simple and molecular formulas, and facts obtainable from the formulas. Chapters 12–14 deal with the balanced equation and problems based on the balanced equation. For solving weight to weight problems, the author uses the mole method. The remaining chapters (15–32) emphasize problems based on the gas laws, on Raoult's laws, on gram molecular volume relationships, on molar and normal solutions, on electro-chemical equivalents, and on ionization.

The book is so clearly written with examples provided, that the beginning chemistry student who is having trouble could, with the aid of this book, analyze his own difficulties and in time become proficient in the solving of chemical problems.

Many practice exercises are found at the end of each chapter. The book should be helpful not only to high school chemistry students, but also to college freshmen taking general college chemistry.

An answer book has been prepared and will be given free of charge to the teacher if request is made to the author.

GERALD OSBORN,
Western Michigan College
Kalamazoo, Mich.

SCIENCE AND THE HUMAN IMAGINATION, Aspects of the History and Logic of Physical Science, by Mary B Hesse, *Lecturer in Mathematics University of Leeds.* Cloth. 171 pages. 14.5×22.0 cm. 1954. Philosophical Library, Inc. 15 East 40th Street, New York City 16, N. Y. Price $3.75.

Science is organized knowledge. Organization comes through interrelatedness. Interelations in science are partially, at least, secured through assumptions. Assumptions, in turn, are products of creative imagination. In this book Dr. Hesse gives this element of science's philosophy a critical assessment.

In nine chapters, prefaced by an Introduction, are presented: Medieval Cosmology (as historic background); New Philosophy (in the renaissance); Billiard-ball Universe (mechanics dominant); Modern Physics and Mathematics (and the uncertainty principle); Status of Scientific Theories (products of imagination); Logical Construction of Scientific Concepts (rules to curb that imagination); Operationalism (and its limitations); Scientific Models (and analogues) and Science and the Natural World (or fitting the model to the real). A bibliography keyed to the individual chapters and a three paged double columned index give the book status for the reader who is also a student.

Many of the paragraphs are addressed to those concerned over the impact of

science on religion. Especially does she appeal to the scientist to relate his newer philosophy arising from quantum mechanics and relativism to the "inherited" assumption that science and religion are in an unresolved disagreement.

However, it would be a distortion of her thesis to imply that the book is primarily treating that controversy. "For the most part the chapters are offered as a straightforward account of recent studies in the history and philosophy of science." From these studies she concludes "scientific discovery is not independend of the climate of thought surrounding it . . . (that) scientific thought can not be understood apart from the general background of the society and culture of its times."

For all interested in science's effect upon man's world of thought and outreach this book will provide stimulating fare.

B. CLIFFORD HENDRICKS,
Hastings College,
Hastings, Neb.

THROUGH THE MATHESCOPE, by C. Stanley Ogilvy, Ph.D., *Assistant Professor of Mathematics at Hamilton College.* Cloth. Pages vii+162. 13.5×20.5 cm. 1956. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $4.00.

Just as astronomers use telescopes and laboratory scientists use microscopes to aid in seeing more clearly the subjects of research, mathematicians sometimes use "mathescopes." This intriguing title is no more intriguing than the contents of this little book. The book is, in the words of the publisher, "designed to acquaint the layman . . . with the intellectually stimulating . . . aspects of mathematics." Certainly this is a book filled with material which will well supplement classroom work of any teacher. If it is placed in the school library, it will without doubt receive wide use. There is a rather wide range of topics of somewhat varying degrees of difficulty, for example: number theory, algebra, geometry, analysis. But these titles are not properly descriptive. There are references to such things as prime numbers, probability, the Pascal triangle, conic seections, the cycloid, elementary problems in the calculus of variations, soap films, pi. The reader will run across several statements which may cause him to pause and reflect; for example: in the Pascal triangle the first number after the one in each row divides all the other numbers in that row if, and only if, it is a prime; even in a perfect vacuum the trajectory of a bullet is not parabolic.

A valuable feature is the "notes" at the end of the book which give further explanations of many topics introduced together with references for further reading. These references include much material which has appeared within the last ten or twelve years. Some of the questions raised will be interesting both to the mathematician and the non-mathematician; for example: find a curve for which the length of a segment in linear units equals the area under that segment in square units.

Although there are other books of somewhat similar nature, each new book of this type adds something of value, and certainly the teacher should be aware of the existence of books of this type and if possible should own a copy as well as placing one in the institutional library.

C. B. READ
University of Wichita

CALCULUS by William K. Morill, *Associate Professor of Mathematics, The Johns Hopkins University.* Cloth. 16×23.5 cm. Pages ×+537. 1956. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, New Jersey. Price $6.00.

This text is somewhat out of the ordinary run of beginning texts. Definitely it tends to be more rigorous. Whether or not the author has attained an objective of writing a text that can emphasize either theory or applications, or both, is debatable.

As illustrative of some of the unusual features, one should point out the use of concepts of nested sequences, null functions, a locally bounded function, a point of accumulation of a sequence, the Weierstrass M-test for uniform convergence, Jacobian determinants. The author stresses the need for testing a function for differentiability, and makes extensive use of null functions in this connection, as well as for work in continuity. Definitions which differ with some usages: the requirement of a *unique* value in the definition of a function (i.e., the exclusion of a "multiple-valued function"); a *critical* point of a function is one at which the derivative is infinite. In many places the author uses a "chart method" to test for maximum or minimum points. To this reviewer, this seemed a surprisingly "mechanical" device in view of the discussion used elsewhere. [Incidentally, although widely used, "chart method" is not found in the index.]

Essentially differential calculus is largely completed before integration is introduced (163 pages, then 20 pages on antidifferentiation, then another chapter on applications of the derivative).

This reviewer felt the definitions of differential and integral calculus on page one were not satisfactory. "The Integral Calculus is the science which enables us to find the lengths, areas, and volumes mentioned above"— is this all? It is hard to see why it is advisable to take the logarithm of both sides when differentiating $y=2^x$ (page 131). There is no discussion as to whether or not Newton's method of approximation will work for any first approximation. Graph 13.8 gives an erroneous idea of the shape of the curve as it crosses the 90 axis. There is a minor misprint in the first line of page 192.

The teacher wishing a text with more than the usual amount of theory should by all means examine this book; it is not unsuitable for a course stressing applications, the choice here is more a matter of individual opinion. There is a chapter on elementary differential equations. There is material for more than the normal one year course. Problems seem ample in number, in general answers are provided for odd-numbered exercises.

CECIL B. READ

COLLEGE ALGEBRA FOR FRESHMEN by Gordon Fuller, *Professor of Mathematics, Texas Technological College*. Second Edition. Cloth. 16×23.5 cm. Pages vii+343. 1956. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, New Jersey. Price $3.85.

This is a text of the traditional type. The reviewer could not detect any marked differences from several texts now on the market (except perhaps such minor items as providing answers to two thirds rather than one half the examples). The author says the problems are new and more plentiful than in an earlier edition.

One wonders why the American Experience Mortality Table is retained rather than the newer C S O. In mathematical induction some teachers would like some problems in which the formula is *not* true. In general in treating laws of exponents the author is careful to impose, when needed, the restriction that the base cannot be zero (an exception occurs on P. 13). In defining an identity the author includes the often omitted restriction that the members of the equation have meaning for a value of the unknown.

In the work on theory of equations Descartes Rule of signs is given without proof; for approximating irrational roots both a method of successive enlargements and Horner's method are presented.

The reviewer wonders why the author (like many others) implies that a graphic solution is not an algebraic method. If this be true, why include it in an algebra text? In treating logarithms, the author follows a traditional practice: Given $\log_{10}2=0.3010$ and $\log_{10}3=0.4771$, find $\log_{10}8$, $\log_{10}6$, $\log_{10}9$, $\log_{10}54$, etc. If the base were 8, or 5, or any number but 10 or e, it would seem the student would be less tempted to "jump ahead" and take the easy method of using the table.

CECIL B. READ

A First Course in Analytic Geometry, *Two and Three Dimensions Treated Simultaneously, by H. Glenn Ayre, Professor and Department Head, Department of Mathematics, Western Illinois State College, Macomb, Illinois,* and Rothwell Stephens, *Professor and Department Chairman, Department of Mathematics, Knox College, Galesburg, Illinois.* Cloth. 16×23.5 cm. Pages viii+224. 1956. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. Price $3.85.

This text is unusual primarily for the simultaneous treatment of two and three dimensional analytic geometry. The authors seem to have been quite successful in their approach. Certain things at first seem unique, for example: lines in two dimensions treated in terms of direction cosines (for example, tests for perpendicularity); symmetric form for equation of a line in two dimensions as well as three; the similarity between the form of equation(s) of a line in two and three dimensions; the treatment, for example, of the hyperbola and the hyperboloid in one chapter; the introduction of polar, cylindrical, and spherical coordinates within the space of a few pages. Although the text is definitely not a combined analytics-calculus, there is a chapter on functions and their graphs which makes use of the derivative and applications to maxima and minima in curve tracing. There is a chapter on empirical equations which this reviewer thought one of the best he has encountered in an analytical geometry text. The final chapter, on vectors and their application in geometry, seems to attempt to crowd into nine pages almost too much material [included are scalar and vector products, vector derivation of the formula for rotation of axes].

Certain features seemed to the reviewer especially praiseworthy: a note on page 5 makes it clear that cartesian coordinates need not be rectangular; it is clearly stated that a line parallel to the y-axis has *no slope*, rather than the statement that the slope is infinite; an exercise gives the point-slope equation of a line as a determinant; even though the first development of the theory of a line as a determinant; even though the first development of the theory of a line in two dimensions utilizes direction cosines, the authors point out certain advantages in using inclination and slope; tests are stated by which one can determine whether a conic is degenerate. Probably no one could write a book which will completely satisfy everyone, this reviewer objected to: the statement on page 1 that algebra was practically unknown to the Greeks [what, for example, about Book X of Euclid's Elements]; it seemed odd, in view of the treatment at other points, not to find distance from a point to a line in two dimensions treated simultaneously with distance from a point to a plane; likewise, the general first degree equation in two and three dimensions respectively are found twenty pages apart; on page 195 the term "line of recession" is unusual—it may be a misprint for "line of regression," or perhaps the reviewer has learned something. The faults are few—this is a book I should like to teach.

Cecil B. Read

Algebra and Its Use, Book 1, by Ethel L. Grove, *Formerly Cuyahoga Heights High School, Cleveland, Ohio; Anne M. Mullikin, Germantown High School, Philadelphia, Pennsylvania;* and Ewart L. Grove, *University of Alabama, University, Alabama.* Cloth. Pages vi+454. 15×23 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y. Price $3.20.

Today one might ask the question: "Why so many algebra texts?" The topics covered in the books of today do not vary greatly from those in the texts of fifty years ago. But now the percentage of pupils to enroll in algebra is so much higher than in the years past that it must be made an attractive subject. In this the authors seem highly successful. Each chapter starts with a page of illustrations and a discussion of important ideas that will be explained in the chapter. Variations in the type used, color schemes, drawings, diagrams, and pictures all are used to emphasize important variations in the thought demanded. Each new concept is introduced so that the student will get a full understanding of the operation. Then the explanation of how the process is done follows in a natural

manner. The problems are classified and numbered so that either the even or the odd numbers may be assigned; or, in large classes, group assignments may be readily made. The marginal illustrations are used presumably to stimulate thought but, in some cases, the reviewer is still asking "what thought." A line of explanation for each sketch might have cleared this. A barber pole is shown on one page, but how many of today's children have ever seen a barber pole? Various styles of type are well selected to set off changes in the character of the work. Mastery and cumulative tests throughout provide the student with review and a means of evaluating his progress. We suggest that you examine this book before making an adoption.

G. W. W.

ELEMENTARY ALGEBRA, by William G. Shute, William E. Kline and William W. Shirk, *Instructors in Mathematics, The Choate School, Wallingford, Connecticut,* also Leroy M. Wilson, *Professor of Mathematics, Middle Georgia, Cochran, Georgia.* Cloth Pages viii+488. 14×22 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y. Price $3.20.

This text, as in the preceding one, makes use of color to stress new and important processes, but in other respects the two books are quite different. This one was put up by teachers in a section where mathematics has long been considered a highly essential subject. The style is more like the traditional type of text, but there are important changes. This very vital trick is to divide each new process into short units so that the student will encounter only one new idea at a time. Illustrative examples are used to show the new parts and carry the student through step by step. All explanations are carefully made and carried to completion so that the student need not depend so much upon teacher help. The text is his teacher. Oral exercises are used throughout to assist the student in proper methods of thinking. Review exercises and cumulative reviews are used in nearly every chapter. "Flashbacks" give considerable history of the subject and create outside reading interests. "Dimbo," a comical figure, helps to point out common errors, but did he not make an unintentiaonal mistake in the illustration on page 118? This is another text you should carefully examine before making your selection. It provides ample material and covers all topics, probably many more, than you will be able to cover. The topic headings for the new processes, such as "Order of operation" page 13 and "Multiplication and division of monomials" page 17 should have been made more prominent by use of larger type.

G. W. W.

THE GYROSCOPE APPLIED, by K. I. T., Richardson. Cloth. Pages 384.15.5×23.5 cm. 1954. The Philosophical Library, New York. Price $15.00.

This book treats the gyroscope and its more important applications in five sections:

1. The Fundamentals —3 chapters
2. Marine Applications —9 chapters
3. Aeronautical Applications —7 chapters
4. Military Applications —2 chapters
5. Other Applications of the Gyroscope—2 chapters

Supplementary sections include a Conclusion dealing with probable future uses of the gyro, and an Appendix presenting some of the simpler mathematics involved, a Bibliography, and an Index.

The author is British. The text material is not limited to British types go gyros however, but includes American and, in some cases, German types as well.

Section 1 treats the basic principles of the gyroscope, gives a bit of historical background and shows how the gyro is affected by gravity and by the rotation of the earth.

Section 2 deals with direction-indicating devices in general and with the gyro-compass in considerable detail. The two types of Sperry (American) gyro-compasses, several types of Brown (British) gyro-compasses, and different types of Anschütz and Plath (German) instruments are described and illustrated with photographs, cut-aways, and line drawings. Automatic pilot devices and stabilizers for ships are explained.

Section 3 on aeronautical applications comprises nearly half of the book. The principles of the directional gyro and the gyro-vertical along with applications of these basic instruments in air navigation are well explained and clearly illustrated. Rate-of-turn indicators, automatic pilots, flight directors, and other airplane instruments are treated in detail.

Section 4 deals with the use of the gyro in gun directors, torpedoes, bombs, and guided missiles.

In Section 5, which is quite short, some of the potential uses of the gyro in such devices as a monorail car and in a system of under-ground surveying are considered. The Conclusion envisions uses of the gyro in possible space ships of the future.

This book is very well written and profusely illustrated. It deals with applications of a strange and generally unfamiliar principle in about as simple a manner as the subject permits. However, few persons except the most ardent gyro enthusiasts are likely to find a book of this type suitable for leisure reading.

WALTER G. MARBURGER
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EXPRESSIONS OF THE EMOTIONS IN MAN AND ANIMALS (Introduction by Margaret Mead), by Charles Darwin. (Revised edition), cloth, 372 pages with 11 additional pages of expressive behavior in the dog (drawings by Konrad Lorenz), expressive behavior among the Balinese (photographic plates) and expressive behavior of speakers during the 1954 Conference on Culture and Communication at the University of Louisville (photographic plates). 13×21.5 cm. 1955. Philosophical Library, Inc., 15 E. 40th Street, New York 16. Price $6.00.

Originally, this subject was to have been a chapter in Charles Darwin's famous book, *Descent of Man*, but he found it so extensive a study that an entire book was written and published in 1872. Even though this was written at an earlier date, modern readers will enjoy this revised edition, not only those who are students of the new science of kinesics, but those who enjoy exploring an original and fresh subject.

In his study of expression and communication, Darwin used infants, the insane, photographs, paintings and sculpture, different cultures of the earth, and some of the commoner animals as his subjects for the intensive study. He accounts for most of the expressions and gestures involuntarily used by man and the lower animals as being due to three basic principles:

1. the principle of serviceable associated habits,
2. the principle of antithesis or opposite actions,
3. the principle of action of the excited nervous system.

He deals with expressions of the lower animals, such as vocal sounds, erection of hairs, feathers, etc., the drawing back of the ears, and other manifestations of emotional influence. Special expressions of man and the effect on his system during low spirits, high spirits, ill-temper, hatred and anger, disgust, surprise, fear, self-attention, etc., are discussed fully.

Through Darwin's powerful imagination and persistent work, it becomes evident that the most complex and fine shades of expression must all have a gradual and natural origin.

BETTY GRAY HARALSON
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Eugene, Ore.

ANALYTIC GEOMETRY, Third Edition, by Charles Sisam, *Emeritus Professor of Mathematics, Colorado College;* and William F. Atichson, *Assistant Professor of Mathematics, University of Illinois.* Cloth. xxiv+292 pages, $8\frac{1}{4}\times5\frac{1}{2}$ inches. Henry Holt and Company, 257 4th Avenue, New York, N. Y. Price $3.75.

During the past twenty-five years, there have been two important innovations in the selection and arrangement of the materials of Analytic Geometry. One is the course in general mathematics for college freshmen, which includes algebra, trigonometry, and analytic geometry. The other is a course which combines analytic and calculus. Both indicate that analytic geometry should not be an isolated course, but a transition between elementary mathematics and calculus. Thus instruction in analytic geometry should look back to algebra and trigonometry as well as ahead to calculus. This text which is a revision of a revision of a successful text, accomplished this by making the study of the relationship of equations and loci the central theme of the course. The study of geometry is not minimized but the study of equations and graphs is stressed.

The introductory chapter reviews algebra and trigonometry with a list of exercises in addition to the usual list of formulas. Chapter one is devoted mostly to the graphing of equations. The ideas of symmetry, intercepts, and excluded intervals are presented here. There is also a section on the intersection of loci. Thus the student has an extension of his knowledge of graphs as an introduction to analytic geometry.

Polar coordinates are introduced after circles. Some additiona. practice in the construction of polar graphs would make this chapter easier for the student. The chapter on conics is not extensive, thus affording more time for higher plane curves and three dimensions. There is a chapter on empirical equations using logarithmic and semi-logarithmic coordinates. More than fifty pages are devoted to the study of three dimensions. Tables and formulas are included. Answers are given to the odd numbered problems.

The text includes enough material for a five hour course, but could be used for a shorter course. The author's use of functional notation and the study of loci and equations should be valuable in preparing students for calculus. The text has many things to recommend it.

HILL WARREN
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UNIFIED ALGEBRA AND TRIGONOMETRY, by Elbridge P. Vance, *Oberlin College.* Cloth. Pages ix+354. 15×21.5 cm. Addison Wesley Publishing Company, Inc., Cambridge 42, Mass. 1955. Price $4.50.

In "Unified Algebra and Trigonometry" E. P. Vance has taken another step in the general direction of unification of three traditional courses, the second course in algebra, college algebra, and trigonometry, with several distinct advantages. Eleven of the seventeen chapters relate to algebra and six to trigonometry, but this division is not exclusive. Some advance is made in the direction of integration over the usual "a chapter of this and a chapter of that" between the covers of the same book. The chapter on inverse functions, for instance, includes both algebraic and trigonometric inverses. This treatment would seem to promote better understanding of both.

The author's arrangement of chapters in this text makes possible a more advanced presentation than is uaually the case. A brief discussion of the number systems and one dimensional coordinate system leads to the rectangular coordinate system and functions. The circular functions are defined in terms of this coordinate system. Again, complex numbers are approached by means of ordered pairs. This work is the basic unifying link for the subjects treated and paves the way for analytic geometry.

As the author mentions in the preface the discussion of periodic phenomena is a distinguishing feature of the text which could easily be capitalized on and

expanded if the class were especially interested in applications. Six pages are devoted to compound interest, its generalization, and its application to the law of natural growth.

The text is "modern" with a vocabulary including "set," "domain," "range," etc. Anyone interested in the changing approach to mathematics will want to examine this book.

WILLIAM MCKILLIP
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SHOP MATHEMATICS, by Claude E. Stout, *Chairman of the Department of Mathematics and Engineering Mechanics, General Motors Institute, Flint, Michigan.* Cloth. 243 pages +tables. 14.5×22 cm. 1955. John Wiley & Sons, Inc., New York, N. Y. Price $3.70.

Shop Mathematics contains a topical presentation of mathematics from simple arithmetic through trigonometry including logarithms and the slide rule. It has been "arranged in four parts to meet the needs of a training program for machinists, tool and die makers, and pattern makers."

Part I covers the arithmetic of whole numbers, fractions, decimals, percent, ratio and proportion, with their application to shop problems.
Part II covers the topics of beginning algebra, again with shop applications.
Part III covers geometry and trigonometry concepts which are applicable to shop situations.
Part IV covers logarithms and the slide rule.

Strong points of the book appear to be its broad coverage of applicable mathematics principles, adequate exercise material with odd-problem answers, and 5-place trigonometry tables to the nearest minute for the six basic trigonometry functions. A 3-place trigonometry table is also located in the body of the book.

Weak points of the book seem to be that the logarithm table and the logarithm of the trig ratios table are located in the body of the book rather than the back, and the book is also noticeably concerned more with the what rather than the why of mathematical principles.

RALPH W. JOHNSON
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KINETIC THEORY OF LIQUIDS, by J. Frenkel, *Academy of Sciences of U.S.S.R. Physico-Technical Institute, Moscow.* Paper. Pages xi+488. 20×13.5 cm. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. 1955. Price $1.95.

This is a reprint of a Russian Publication of July 1943, the publication of which had been delayed due to mailing difficulties of the war. The reprint is an English translation of 1946.

One who reads this book must be well versed in mathematics, including tensor analysis, otherwise it is almost meaningless.

The author treats such problems as dipole orientation, fusion, thermal conduction, electrical conduction, diffusion, viscosity, etc. The transition from solids to liquids from a theoretical standpoint are very well worked out. Emphasis is given to the liquid state however. He makes a unified theory of both states, that is, solid and liquid, comparing the rigidity and order of the liquid state with the disorder and movement in crystals.

It is a good source-book for those interested in the theoretical and experimental research of the problems discussed.

JAMES W. BOYNTON
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Kalamazoo, Mich.

ALGEBRA COURSE 1. Cloth, Pages xi+484. 16 cem. ×23.5 cm., $3.00. By Howard Fehr, Walter Carnahan, Max Beberman, D. C. Heath and Co., Boston, 1955.

ALGEBRA, COURSE 2. Cloth, Pages x+502. 16 cem×23.5 cm., $3.00. By Howard Fehr, Walter Carnahan, Max Beberman. D. C. Heath and Co., Boston, 1955.

Here are two well written standard Algebra books. Course 1 covers material up through simple quadratics and contains what most schools will want to teach in grade nine. Course 2 provides the usual review and continues through permutations, simple probability and the basic ideas of Calculus. In the second book there is probably more material than would be covered in a third semester of Algebra but not a sufficient amount for a full second year course.

Special characteristics of the texts include pre-assignment practice exercises, vocabulary reviews, discovery exercises, chapter summaries, arithmetic reviews and general reviews.

Throughout both texts there are many questions on the why of the operation as well as the how. The general format may tend to lead the pupil to work by imitation in that there is given an example, its solution and its check, then follows a series of problems using this general form of solution. The problems are good and plentiful with probably more of the drill type exercise than will be needed. The historical material is put in separate chapters and one wonders if it will be used in this manner. The texts are well motivated by the use of pictures and items of mathematical information which are not commonly known. One then missing from both texts is the use of permutations, the binomial expansion and probability in the field of statistics. The slide rule is only mentioned. The basic laws of algebra are given in course 2 but not used in proving the correctness of the fundamental operations. There were very few errors found by the reviewer and these were not serious. The printing is good, the tables well done and the pictures interesting as well as aids to teaching.

PHILIP PEAK
Indiana University

FUNCTIONAL MATHEMATICS, Book 3 by Gager, William A.; Lyle, Lilla C.; Shuster, Carl N.; Kokommor, Franklin W. Cloth, Pages xiii+481. 26×16 com. 1955. Charles Scribner's Sons, New York, $3.20.

This is the third in a four-book series presenting high school mathematics as an integrated subject. The third book is developed around measurement, application of exponents, logarithms, trigonometry series and graphing. Through this framework the student is introduced to many of the ideas found in the traditional high school mathematics course. For example under measurement we find treated precision, accuracy, relative error, significant digits, metric measure, nautical measure area and perimeter of plane and solid figures as well as volume of the latter. This includes spheres, zones, spherical polygons, frustums, cones and certain irregular solids. Angles measures in degrees, radians and mils is included.

Exponents and logarithms are developed through the use of the Pythagorean theorem, special kinds of triangles, Hero's formula, problems involving the sphere, the use of standard notation, the use of the slide rule and problems where trigonometric ratios are used.

There are 10 pages which give an introduction to vectors and their use in problems of force and speed. Ratio proportion and variation is illustrated and used in problems taken from industry and situations using physical phenomena.

There are 38 pages discussing and applying reasoning. This material compares mathematical analysis with that of everyday life. It introduces methods of reasoning such as inductive, deductive and indirect. It also points out errors in reasoning such as false assumptions, non sequiter, undefined terms and circular reasoning. There are illustrations of these forms of reasoning but problems used to fix the ideas developed leave much to be desired. There seems to be some lack

of clearness about truth and what it is. Perhaps it is better not to try to define it in this situation.

There is a good deal of repetition between books 1, 2 and book 3. The teacher who uses it will have to decide if the repetition is the proper amount. There are references throughout the text to previous work and in this manner the whole is tied together. The reviewer feels that in some instances the introduction to a topic could have been developed more from an understanding point of view for example, beginning on page 11 where computation with measurement is developed, and beginning on page 279 where trigonometric ratios are developed. There are a few places where an idea was developed but then not used until a good deal later in the text.

The numbers system and its extension into complex numbers is well done and should help the student see the nature of the system.

The text is well supplied with problems of a practical nature and the student who can solve them should have facility in computation. Somewhat more emphasis could be placed on the principles being applied although it is not entirely ignored. Schools looking for a text which allows them to teach mathematics without being bound by areas of Algebra, Geometry, etc. should by all means examine this text.

PHILIP PEAK
Indiana University

SCIENCE FOR PROGRESS, by Maurice U. Ames, Principal, *Frank D. Whalen Junior High School, New York City;* Arthur O. Baker, *Directing Supervisor of Science, Cleveland Board of Education;* and Joseph F. Leahy, *Herrick Junior High School, Cleveland.* Cloth. 568 pages. 1956. Prentice-Hall, Inc., Englewood Cliffs, N. J. Price $4.40.

Science for Progress is a general science textbook most adaptable for a ninth grade class. It could also be used as a reference book for eighth grade general science. The text has been especially designed to achieve the objectives of science teaching as listed in the *Forty-sixth Yearbook of the National Society for the Study of Education.*

The authors have attempted to achieve the above mentioned objectives by setting up a series of nine cycles, which are sub-divided into a total of thirty-seven major problems or topics. These nine cycles are: "Scienific Approach to the Problems of Living," "Securing Your Food," "Securing Good Health," "Securing a Good Home Environment," "Securing Recreation," "Communicating With One Another," "Transportation of Persons and Materials," "Securing Continued Existence," and "Using and Controlling the Natural Environment." Throughout these cycles the questions of where, how, and why are answered to show the scope of science and its impact upon society.

Cycle One, "The Scientific Approach to the Problems of Living," illustrates this idea of the importance of science to society by introducing the student to the problems involved in the production of a wonder drug and also the methods by which atomic energy is released. These timely topics should help develop the students' curiosity and interest early in the year and give the class the proverbial "start on the right foot."

Clarity of the language used, the many colored pictures and excellent diagrams, careful selection of materials which should be of interest to young people, and an excellent glossary of terms are just a few of the characteristics which make this a very good text for ninth grade general science. The important problems and principles are clearly summarized at the end of each cycle. Applications of these important ideas are not only discussed in the text but are also emphasized with good "Can You Do These?" experiments and "How Would You Answer These?" questions.

One of the more interesting features of this text is the use of historical anecdotes throughout each problem. A good example of this can be found at the beginning of Cycle Six, "Communicating With One Another." A story tells of

the use of heliograph signals for help by a group of English soldiers who were surrounded by the Boers during the Boer War in Africa. Many developments and improvements brought about by science are similarly discussed through this historical approach.

Teachers planning for a new text for ninth grade general science or for a reference book for the seventh and eighth grades should find *Science for Progress* worthy of their full consideration.

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MICROBIOLOGY, an introduction, by Ernest A. Gray. Cloth. 175 pages. Philosophical Library, Inc., 15 East 40th Street, New York 16, New York. Price $3.75.

This little volume is designed as an introduction to microbiology to supplement some of the information usually included in the study. As stated in the preface it is not intended to replace any of the well known volumes dealing with microbiology but to help the student with what he is doing.

The book is written in such a way that it can be understood by those not too familiar with the study of microbiology. There are included many interesting discussions that should aid the student in the study of certain organisms to better understand what he is doing and the relationshlp one group has to another.

Here is a valuable source of supplementary information to the beginner in microbiology. It makes for interesting reading for biology teachers and those interested in a general interesting discussion of micro-organisms.

The groups of micro-organisms are discussed individually but relationships are not neglected. Simple language is used to explain more difficult topics. Historical comments add to the topics being discussed.

N. L. L.

ON THE NATURE OF MAN. AN ESSAY IN PRIMITIVE PHILOSOPHY, by Dagobert D. Runes, Cloth, 105 pages. 13.5×24.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 19, New York. Price $3.00.

A fascinating little book that can be a challenge to those of us that are prone to accept every thing as it is today without question. The author takes us to the early beginnings of man to consider what things were then and to briefly question many of the common policies, facts and general beliefs we commonly accept today.

Consideration is given to the borderlines of human thinking and human morality. Why does man act as he does? Why does he do some of the things he does? What influences man and causes him to do the kinds of things we observe him doing? These are but a few of the thoughts brought out in the book with a bit of interesting philosophy.

Man is described as an unstable being that does change as conditions about him change whether for the better or for the worse. He has not always advanced with changes in the ruling powers or grown as we assume with the centuries that have passed since the early beginning of man.

A difficult book to describe but one in which most readers will immediately become engrossed if interested in man and philosophy. The last pages are filled with many philosophical thoughts, some which are new and others which have often been used.

N. L. L.

Kindness is the golden chain by which society is bound together.

—GOETHE

OBSERVATIONS ON A KUNDT'S TUBE

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Throughout its history the Kundt's tube apparatus has repeatedly given rise to questions not easy to settle. Indeed, many illustrious names are associated with certain curious details—Regnault, Helmholtz, Rayleigh, Andrade—to name only a few of the older days. This note points up just one more observation which, on inquiry, appears not easy either.

The usual arrangement is well known. The rod to be stroked, clamped at its midpoint, has a disc at its end which *just nearly* fills the tube. The closed end of the tube is equipped with a "stopper." Generally, this stopper *fills* the tube, that is, its edges are flush with the walls of the tube, as would be if the stopper is a uniform cylinder. Reflection then, takes place from the surface which is normal to the axis of the tube.

In the case I report the stopper was a *tapered* rubber stopper which went into the tube about an inch. This left an annular ring between the stopper and the tube wall, V-shaped in depth. It was interesting to discover that excitation of the cork dust was impossible to achieve with this arrangement. When the tapered stopper was replaced by a cylindrical one the tube responded at once. What shall we say of this? Was too much energy lost in the V-shaped recess? Or is the nodal plane *at the closed end undefined?*

COLORADO COLLEGE AND CARNEGIE TECH COOPERATE

Colorado College and Carnegie Institute of Technology announced plans today to cooperate in a five-year educational program leading to both liberal arts and engineering or science degrees.

The cooperative program, known as the 3-2 plan, was announced jointly by President Louis T. Benezet of Colorado College and Carnegie President, J. C. Warner.

The plan provides for three years of liberal arts with a major in science at Colorado College and two years of engineering or science at Carnegie Tech. At the end of the five years students will receive a bachelor of arts degree from Colorado College and a bachelor of science degree from Carnegie.

Transfer 3-2 students from Colorado College will be able to study one of Carnegie's three pure science curriculums: chemistry, physics, or mathematics; or may choose one of the five engineering departments: civil, electrical, mechanical, chemical or metallurgical. They may also enter the Department of Industrial Management.

Colorado College is the twenty-fourth liberal arts college to join with Carnegie Tech in the 3-2 program.

In the past decade, according to Carnegie officials, the duties of engineers have grown complex with the interweaving of engineering duties and huge administrative and managerial chores in business and industry. As one prominent

executive said, "Industry is constantly seeking potential executives who can understand the problems of the engineer and scientist. But, at the same time, we want our leaders to be able to see beyond the laboratory walls—and even beyond company boundaries, into the national and international economic, political and social world."

One answer to the problem is the 3-2 plan at Carnegie Tech. The plan allows the student a broad liberal arts foundation before he undertakes a technical curriculum. It also gives the undecided student some college experience which helps him choose whether he really wants to study engineering or science.

"Because of these advantages," Carnegie's President Warner said, "we have invited selected liberal arts colleges to join with us and we are indeed happy to welcome into the 3-2 plan so fine an institution as Colorado College."

In Colorado Springs, Colorado, the seat of Colorado College, President Benezet said, "We consider the affiliation with Carnegie Tech a forward movement in our program to furnish pre-professional education to the best sort of completion. The 3-2 plan established between selected liberal arts colleges and America's great engineering schools is recognized as an ideal way to give promising students breadth of learning and top professional preparation in one continuous program. We look forward to associations with Carnegie Tech in enlarging our work of launching scientists and engineers upon their careers."

Colorado College, established 1874, and the oldest college of liberal arts in the eight-state Rocky Mountain Region, has a coeducational enrollment of 1,000 students. Beyond the first two years of general studies, the curriculum offers a choice of specialization in 21 liberal arts fields.

Carnegie Tech, one of the nation's outstanding professional schools, includes a College of Engineering and Science, College of Fine Arts, the Margaret Morrison Carnegie College (for women), a Graduate School of Industrial Administration and a School of Printing Management.

SIXTH JOHN HAY FELLOWS PROGRAM ANNOUNCED

The John Hay Whitney Foundation has announced that it is accepting applications for the John Hay Fellowship program for 1957–58. Nominations will be welcomed on behalf of qualified public high school teachers in the states of Georgia, Kentucky, Minnesota, North Dakota, South Carolina, South Dakota, Washington, and West Virginia.

Fellowships for a period of one academic year will be awarded to a limited number of outstanding senior high school teachers from these eight states for study in the broad area of the humanities at either Yale University or Columbia University. The Fellows will participate in special programs developed in cooperation with the faculties of these institutions and will have an opportunity to study under great scholars and teachers and to explore areas of knowledge related to their teaching fields and to their personal academic interests.

Fellowship awards provided by the John Hay Whitney Foundation will include stipends equal to the salaries received from the employing school during the fellowship year. In no case will the award be less than $3,000.00 and grants for tuition and transportation are also given.

All applicants are nominated by the local superintendent of schools or other school official who is in a position to help plan a proposed program of graduate studies and to utilize the Fellows' new experience upon their return to high school teaching. As in the past five years during which the program has been in operation, each teacher accepted for study as a John Hay Fellow must be granted a year's leave by his employing school system and must agree to return to it following his university work for at least one year.

Teachers must be no more than 45 years of age and have at least five years of high school teaching experience, the most recent two of which shall have been in the present employing school system.

While such fields as language, literature, history and the fine arts are most commonly associated with the humanities, nominations will be welcomed from eligible teachers of other subjects, including the social sciences and the natural sciences.

Inquiries from teachers and administrators should be directed to the Division of the Humanities, John Hay Whitney Foundation, 630 Fifth Avenue, New York 20, New York. The deadline for receipt of completed nominations is May 31, 1956.

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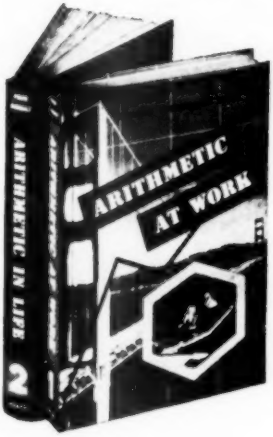

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